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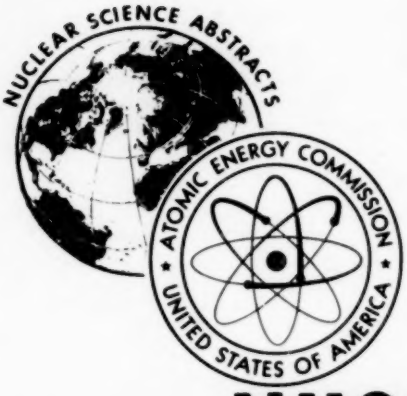

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Volume 17, Number 1, January 15, 1963

NUCLEAR SCIENCE ABSTRACTS

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Notice

Volume 17 of *NSA* contains a few changes in form and presentation which should increase its usefulness and speed its preparation. The important changes are listed below.

ALLOYS

Multicomponent alloys, except well-known trade names, will be indexed under each element in the alloy.
Example: Aluminum–Chromium–Iron Alloys will be indexed

ALUMINUM ALLOYS
  Al–Cr–Fe ...
CHROMIUM ALLOYS
  Al–Cr–Fe ...
IRON ALLOYS
  Al–Cr–Fe ...

The heading ALUMINUM–CHROMIUM–IRON ALLOYS will not be used. Well-known alloys such as Hastelloy will be indexed directly with cross references under the element components.

PROGRESS REPORT SHORT TITLES

Short titles for progress reports which are included in the personal author and corporate author indexes will now include, where possible, the inclusive dates of the work reported.

NEW CATEGORIES

The subcategory "Instruments" previously under "Engineering" is now a major category "Instruments and Instrumentation" and will include the subcategories "General and Miscellaneous" and "Radiation Detection." A new subcategory "Organic Chemistry" is added under the major category "Chemistry."

JOURNAL ABBREVIATIONS

Journal abbreviations have been changed in this volume to conform to the new style adopted by *Chemical Abstracts* and published in its *List of Periodicals, 1961.*

TRANSLATIONS

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Use of funds for printing this publication has been approved by the Bureau of the Budget, July 29, 1960.

Volume 17, Number 1 January 15, 1963

NUCLEAR SCIENCE ABSTRACTS

GENERAL AND MISCELLANEOUS

1 (AERE-READING LIST-10) THE USES OF RADIOISOTOPES. R. Sweeney, comp. (United Kingdom Atomic Energy Authority. Research Group. Wantage Research Lab., Wantage, Berks, England). June 1962. 2p.

A bibliography containing 26 references on the uses of radioisotopes is presented. The uses are categorized into the following groups: general, industry, agriculture, biological sciences, and medicine. (N.W.R.)

2 (BMI-1589(Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JULY, 1962. Russell W. Dayton and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). Aug. 1, 1962. Contract W-7405-eng-92. 48p.

Progress is reported on developments in atomic energy for civilian application. Topics covered include: reactor materials and components, fuels, fuel-element development, radioisotope and radiation applications, materials development and evaluation, coated-particle fuel materials, fuel-irradiation program, supporting research program, corrosion studies of the Fluoride Volatility Process, progress on USAEC-AECL Cooperative Program, fission product deposition studies, radiation-effects study of candidate fuel materials for the MGCR, irradiation of materials and components, gas-cooled reactor program, and process development and evaluation of properties of F-48 niobium alloy. (M.C.G.)

3 (ORNL-2971(Vol.6)) BIBLIOGRAPHY ON NUCLEAR REACTOR FUEL REPROCESSING AND WASTE DISPOSAL. VOLUME 6. PROCESS CHEMISTRY AND ENGINEERING. T. F. Connolly (Oak Ridge National Lab., Tenn.). Contract [W-7405-eng-27]. 285p.

Section 6 of 8 sections comprising a bibliography on reactor fuel reprocessing and waste disposal is presented. The complete collection includes about 7000 abstracts, most of which were obtained from Nuclear Science Abstracts. Most of the material dates from the 1955 Geneva Conference to the present. (J.R.D.)

4 (STI/DOC/10/9) IAEA RESEARCH CONTRACTS SECOND ANNUAL REPORT. Technical Reports Series No. 9. (International Atomic Energy Agency, Vienna). 1962. 70p.

Summaries are presented for those research contracts which expired between December 31, 1960 and December 31, 1961. Topics covered include: factors controlling distribution of fission products in biosphere, non-destructive methods of evaluating the U^{235} and Pu content of irradiated fuel elements, studies of contamination in local marine resources, tracer studies of anemia, non-destructive analysis of irradiated fuel elements using a flux integrating monitor, mechanism of proteolysis of I^{131}-labeled fibrinogen, radiosensitivity of spermatogonia of Drosophila melanogaster, non-destructive analysis of irradiated fuel elements by gamma scanning, uptake and loss of radioactive material by marine bacteria, factors which influence the movement of radioactive strontium from soils to plants, biological concentration of fission products in mollusks from water, decay scheme of Tl^{210}, calcium balance in metabolic bone disease, development of radioactive drugs with special reference to tritiated drugs as radiotherapeutic agents, and physicochemical requirements for the disposal of low-activity liquid radioactive wastes in soil. (M.C.G.)

5 (TID-3713) INFORMAL LISTING OF BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Bibliographies Issued or in Progress During the Period, August – September 1962. (Division of Technical Information Extension, AEC). 29p.

The bibliography is comprised of 174 entries; subject, author, and report number indexes are included. (J.R.D.)

6 THE LIGHT OF THE ATOM BOMB. Clay P. Butler (Naval Radiological Defense Lab., San Francisco). Science, 138: 483-9(Oct. 26, 1962).

The primary reason for measuring thermal radiation from nuclear weapons is to evaluate the hazards associated with the heating of exposed objects. These hazards include cutaneous burns in humans, flash blindness, retinal burns, heating and subsequent weakening of wings and control surfaces of aircraft, and the ignition of kindling fuels such as those that helped produce the great fire at Hiroshima. Studies on these effects call for detailed information on the thermal radiation, including its spectral distribution, the irradiance history and the total energy as a function of distance, weather, and other factors. Rough scaling laws, that relate the diameter and power temperature of the fireball with the time and yield, make it possible to predict thermal radiation damage for a wide variety of conditions. These laws are based on data accumulated from weapons tests during the period between 1948 and 1958. Data are presented graphically on the luminous efficiency of a nuclear fireball in air with a comparison with other familiar light sources. Comparison is also made between the light from a fireball and light from the stars and from the sun. (C.H.)

7 DOORWAY TO LEGAL NEWS. VOL. 6, NO. 3, 1962. (Division of Technical Information, AEC). 222p.

An annotated bibliography on legislative, regulatory, and legal literature on nuclear science and technology is pre-

sented. Abstracts are presented on current books; monographs; reports of government agencies; educational, industrial, and research organizations; U. S. Congressional studies; federal, state, and foreign legislation; and selected translation and legal articles. All federal legislation of interest to the Atomic Energy Commission is digested and carries a chronological status report. (N.W.R.)

8 DOORWAY TO LEGAL NEWS. VOL. 6, No. 4, JUNE 1962. (Division of Technical Information, AEC). 250p.

An annotated bibliography on legislative, regulatory, and legal literature on nuclear science and technology is presented. Abstracts are presented on current books; monographs; reports of government agencies; educational, industrial, and research organizations; U. S. Congressional studies; federal, state, and foreign legislation; and selected translation and legal articles. All federal legislation of interest to the Atomic Energy Commission is digested and carries a chronological status report. (N.W.R.)

9 THE RESEARCH PROGRAM FOR THE WHITESHELL NUCLEAR RESEARCH ESTABLISHMENT. R. F. S. Robertson (Atomic Energy of Canada Ltd., Chalk River, Ont.). Preprint. [Ottawa], Canadian Nuclear Association, 1962. 10p.

The Whiteshell Nuclear Research Establishment will be a center devoted to further development of nuclear power, and will concentrate initially on work in the fields of chemistry, chemical engineering, fuel development, and metallurgy. Experimental reactors to test more advanced concepts will be built; the first will be the Organic Test Reactor. Floor plans for the proposed Research and Development Building are included. (A.G.W.)

10 NUCLEAR ENERGY IN SPAIN. F. Pascual (Junta de Energia Nuclear, Madrid). Preprint. [Ottawa], Canadian Nuclear Association, 1962. 18p.

Estimates of future electrical energy requirements in Spain and possible sources of this energy indicate that nuclear power stations will be needed. The program for development of these stations can be divided into two parts: (1) a short-term program to provide a minimum of three stations of a proven type by 1972-73; (2) a long-term program to develop the heavy-water-moderated, organic-cooled reactor which appears to best meet Spain's needs. Facilities for mining and processing U are being extended. Three experimental reactors are in operation and a power reactor is being developed. Activities of state-owned and private industries in the field of nuclear energy are summarized. (A.G.W.)

11 ADVANCES IN CRYOGENIC ENGINEERING. VOLUME 7. Proceedings of the 1961 Cryogenic Engineering Conference, University of Michigan, Ann Arbor, Michigan, August 15-17, 1961. K. D. Timmerhaus, ed. A Cryogenic Engineering Conference Publication. New York, Plenum Press, 1962. 590p. $15.00(domestic), $17.50(foreign).

Seventy-one papers and two summaries of papers are given. The papers are grouped under the following headings: invited papers; space simulation; physical equilibria; equipment; fluid transfer phenomena; cryogenic properties; heat transfer phenomena; mechanical properties and test procedures; selected short papers. Fifteen papers are covered by separate abstracts. (A.G.W.)

12 APPLICATION OF CRYOGENIC CALORIMETRY TO SOLID-STATE CHEMISTRY. E. F. Westrum, Jr. (Univ. of Michigan, Ann Arbor). Advances in Cryogenic Eng., 7: 1-15(1962).

Low-temperature heat capacity data provide a powerful tool for the study of condensed phases. A cryostat and calorimeter used for accurate heat-capacity measurements are described. Current problems in the cryogenic area are reviewed with emphasis on those being studied at the Univ. of Mich. Among the subjects discussed are normal heat-capacity behavior, heat capacity anomalies, calorimetric study of phase diagrams, and the plastically crystalline state. (A.G.W.)

13 DESIGN AND TEST OF A GAS-ADSORPTION SYSTEM FOR THE N.S. SAVANNAH. G. Y. Robinson, Jr. (Arthur D. Little, Inc., Cambridge, Mass.). Advances in Cryogenic Eng., 7: 137-42(1962).

The N.S. Savannah is powered with a 69-Mev, UO_2-fueled, pressurized-water reactor. A low-temperature adsorption unit using refrigerated charcoal beds was designed to remove and store fission-product gases for a 100-day period. The purification cycle, design features, engineering test results, and design data for adsorption of gases on activated charcoal at low temperatures are discussed. (A.G.W.)

14 IN-PILE LOOP CRYOGENIC REFRIGERATOR. A. M. Liebschutz (Lockheed Aircraft Corp., Dawsonville, Ga.) and C. A. Schulte. Advances in Cryogenic Eng., 7: 181-8(1962).

A refrigerator is being designed to furnish a cryogenic environment for in-pile loop samples during reactor irradiation. The refrigeration medium is He gas continuously circulated at two different pressure levels, 50 and 300 psia. The system provides for three interchangeable test loops to be connected at one time. Cool-down time will be 30 min or less, and test-sample temperature will be maintained within the range 30° to 540°R to ±1°R. Each component of the system is described. (A.G.W.)

15 LIQUID-HYDROGEN FLOWMETER CALIBRATION FACILITY. H. L. Minkin, H. F. Hobart, and I. Warshawsky (National Aeronautics and Space Administration, Cleveland, Ohio). Advances in Cryogenic Eng., 7: 189-97 (1962).

The facility described permits calibrations in the range of 0.05 to 1 lb m/sec of flowmeters up to about 1.5-in. nominal line size. The highest flow rate can be maintained for 3 min. Static pressure is about 30 psia. Details of some special construction features and of the measurement checks made are given. Some illustrative preliminary data on head-type and turbine-type meters are presented. (A.G.W.)

16 PROBLEMS IN COOL-DOWN OF CRYOGENIC SYSTEMS. J. C. Bronson, F. J. Edeskuty, J. H. Fretwell, E. F. Hammel, W. E. Keller, K. L. Meier, A. F. Schuch, and W. L. Willis (Los Alamos Scientific Lab., N. Mex.). Advances in Cryogenic Eng., 7: 198-205(1962). (LADC-4856)

Several problems anticipated in handling large quantities of liquid H_2 were studied. Experiments with a vacuum-jacketed, horizontal mock-up of a heavy-wall transfer line indicated that liquid cool-down can be accomplished without establishing large circumferential temperature gradients and consequent bowing of transfer lines if a specified minimum flow is maintained. Calculations of cool-down time, liquid coolant requirements, and pressure fluctuations during cool-down were made and verified experimentally. (A.G.W.)

17 GAS REQUIREMENTS IN PRESSURIZED TRANSFER OF LIQUID HYDROGEN. D. F. Gluck and J. F. Kline (National Aeronautics and Space Administration, Cleveland). Advances in Cryogenic Eng., 7: 219-33(1962).

An analytical relation was developed to express gas requirements for the pressurized transfer of liquid H_2 from

a cylindrical tank as a function of known system parameters and two quantities to be experimentally determined, i.e., interfacial mass transfer and gas-phase heat transfer. An experimental investigation was made to evaluate unknown parameters and test theoretically derived relations. For the conditions studied it was found that the effect of mass transfer on gas requirements was negligibiy small. A correlation was developed to predict heat transfer to the walls, which was found to be the major factor in gas-phase heat transfer. Deviation of experimental values of gas requirement from predicted values calculated by the proposed procedure was 3.52% average and 9.0% maximum. (A.G.W.)

18 THE STRUCTURE OF THE ALLOTROPIC FORMS OF He^3 AND He^4. A. F. Schuch and R. L. Mills (Los Alamos Scientific Lab., N. Mex.). Advances in Cryogenic Eng., 7: 311-17(1962). (LADC-4854)

Helium is now known to have three solid forms of each isotope, He^3 and He^4. A cryostat and x-ray-diffraction apparatus were developed for studying structures at low temperatures. Powder and Laue techniques were used to study the structure of the forms of He^3 and He^4. For He^3 it was found that below 3.15°K the structure is body-centered cubic; immediately above this temperature it is hexagonal; and at some higher temperature, around 18.5°K, it becomes face-centered cubic. He^4 in the middle temperature and pressure range is hexagonal; the high-pressure form is face-centered cubic; the low-pressure form is still being studied. A table shows the size of the unit cell and molar volume of each form of each He isotope at some definite temperature and pressure near the melting line. (A.G.W.)

19 NEW EFFECTS IN SUPERCONDUCTIVITY. J. Nicol, J. L. Miles, S. Shapiro, and P. H. Smith (Arthur D. Little, Inc., Cambridge, Mass.). Advances in Cryogenic Eng., 7: 318-26(1962).

Two groups of experiments were performed to determine the properties of a superconducting metal at its boundary with other metals and dielectric materials. The first group involved measurement of the current produced by electron tunneling through thin dielectric layers between superconducting metals. The existence of the energy gap in the conduction electron spectrum in a superconducting metal was demonstrated. Gap widths were measured in Pb, Al, In, and Sn, and their temperature dependence was found to agree with the predictions of the BCS theory. The second group of experiments involved the properties of laminar structures formed by depositing a superconducting metal and a nonsuperconducting metal in intimate contact. It was found that the assembly acts as a unit, a laminar superconductor, with properties of its own. (A.G.W.)

20 ELECTROSTATIC HAZARDS ASSOCIATED WITH THE TRANSFER AND STORAGE OF LIQUID HYDROGEN. L. Cassutt, D. Biron, and B. Vonnegut (Arthur D. Little, Inc., Cambridge, Mass.). Advances in Cryogenic Eng., 7: 327-35(1962).

The electrical conductivity of liquid H_2 was measured in the laboratory. In field experiments the degree of electrostatic charge generation was measured in scale-model equipment under simulated storage and transfer conditions. Results indicated that significant electrostatic charges can be generated in well-grounded systems during storage and handling. Because of the extremely low electrical conductivity of H_2, the charges persist over long periods of storage. The most serious condition for buildup arises during two-phase flow in transfer operations. The level of charge buildup in all tests was insufficient to cause spark ignition. It was concluded that the electrostatic hazards in flow of H_2 in the liquid phase would normally be less than for petroleum fuels. (A.G.W.)

21 HEAT TRANSFER TO AN UNINSULATED SURFACE AT 20°K. D. A. Van Gundy and J. R. Uglum (Beech Aircraft Corp., Boulder, Colo.). Advances in Cryogenic Eng., 7: 377-84(1962).

In order to predict the performance of uninsulated liquid-hydrogen tanks, experiments were performed to determine the overall heat-transfer coefficient to an uninsulated flat Cu plate. One side of the Cu plate was maintained in contact with liquid hydrogen; the opposite side was exposed to air with controllable velocity, temperature, and humidity. A table shows steady-state heat flux determined for various air conditions. The highest heat transfer rates occurred when frost did not accumulate and liquid air continually flowed down the test surface. Frost thickness increased with increasing absolute humidity with a slight leveling off at high humidities. Heat transfer coefficients decreased with increasing absolute humidity until frost thickness started to level off. No correlation between experimental data and theoretical analysis was obtained. (A.G.W.)

22 HEAT TRANSFER TO CRYOGENIC HYDROGEN AT SUPERCRITICAL PRESSURES. W. R. Thompson and E. L. Geery (Aerojet-General Corp., Azusa, Calif.). Advances in Cryogenic Eng., 7: 391-400(1962).

Heat transfer data for cryogenic hydrogen flowing through a 16-in. stainless steel tube with an ID of 0.194 in. and a heated length of 8 in. were obtained for the following ranges of variables: pressure, 680 to 1344 psia; hydrogen inlet temperature, 55° to 102°R; local linear velocity, 19 to 369 ft/sec; heat flux 0.11 to 8.0 Btu/in^2-sec; max. bulk temperature, 238°R; max. inner-wall temperature, 1594°R; and wall-to-bulk temperature ratio, 1.36 to 16.5. It was found that heat is transferred to cryogenic hydrogen through two modes or mechanisms. The occurrence of a minimum in the generalized heat-transfer coefficient in the region of the critical temperature was confirmed. A second minimum was found to occur at a bulk temperature about 50° to 70° higher. (A.G.W.)

23 AN EXPERIMENTAL INVESTIGATION OF THE INDIVIDUAL BOILING AND CONDENSING HEAT-TRANSFER COEFFICIENTS FOR HYDROGEN. D. E. Drayer and K. D. Timmerhaus (CEL National Bureau of Standards, Boulder, Colo.). Advances in Cryogenic Eng., 7: 401-12(1962).

The relationship between the individual film heat-transfer coefficients and the variables of temperature difference and heat flux for boiling and condensing hydrogen films on a smooth vertical tube surface was studied experimentally. The boiling occurred on the outside surface while the condensing took place on the inside surface. Boiling heat-transfer coefficients determined over a temperature difference range of 0.06° to 1.17°F for a heat flux spread of 23 to 978 Btu/hr-ft^2 varied from 360 to 800 Btu/hr-ft^2-°F. Condensing heat-transfer coefficients determined for a 4.44-in.-long tube over a temperature difference range of 0.31° to 4.69°F and a heat flux spread of 31 to 1310 Btu/hr-ft^2 varied from 90 to 300 Btu/hr-ft^2-°F. Overall heat-transfer coefficients determined over a temperature difference range of 0.38° to 6.06°F and a heat flux spread of 23 to 978 Btu/hr-ft^2 varied from 44 to 146 Btu/hr-ft^2-°F. Experimental results are compared with theoretical and empirical correlations for predicting boiling and condensing heat-transfer coefficients for normal fluids. (A.G.W.)

24 TENSILE–COMPRESSION–SHEAR LOOP FOR IRRADIATION TESTING AT CRYOGENIC TEMPERATURES. W. L. Bridges and A. M. Liebschutz (Lockheed Aircraft Corp., Dawsonville, Ga.). Advances in Cryogenic Eng., 7: 440-7(1962).

An apparatus is described which makes it possible to ir-

radiate specimens of metals and alloys in a reactor at temperatures from 30° to 540°R and measure tensile, compression, and shear properties at the same temperature without interim warming. The refrigerant is gaseous He; unrefrigerated portions of the test loop are water-cooled. Test specimens may be changed by remote-handling techniques within a minimum time. The entire test loop is contained in a 6-in.-dia. type-304 stainless steel envelope. Miniature specimens are used. A program to establish a correlation between data on miniature specimens and similar data obtained from conventional large specimens was conducted. (A.G.W.)

25 A MULTIPLE TENSILE SPECIMEN TEST DEVICE FOR USE IN LIQUID HYDROGEN. R. D. Keys (Martin Co., Denver). Advances in Cryogenic Eng., 7: 455-8 (1962).

A multiple-specimen-holding device for making tensile tests of flat-sheet specimens in liquid hydrogen is described. A chain-link loading and specimen-advance system is used to test up to six specimens in sequence. Up to 30 specimens can be tested in one 8-hr work day. Close agreement of results on similar tests was obtained. (A.G.W.)

26 TEMPERATURE-ENERGIZED STATIC SEAL FOR LIQUID HYDROGEN. S. E. Logan (ACF Industries Inc., Albuquerque, N. Mex.). Advances in Cryogenic Eng., 7: 556-61(1962).

The seal consists of an elastomer molded onto a ring of Invar. When the assembly is cooled, the flange of Al or stainless steel contracts more than the Invar ring. The differential contraction of the metallic components results in compressive stress in the sealing material which increases as the temperature is lowered. Satisfactory performance of the seal was obtained for pressures as high as 1800 psi. Temperature and pressure cycling had no deteriorating effect. (A.G.W.)

BIOLOGY AND MEDICINE

General and Miscellaneous

27 COBALT 60 KILOCURIE TELETHERAPY; ADVANTAGES AND LIMITATIONS— TECHNICAL PROBLEMS. Maria Brites Patricio (Inst. Portugues de Oncologia, Lisbon). Arquiv. Patol. (Lisbon), 33: 147-55(Dec. 1961).

The advantages of Co^{60} therapy over conventional x-ray therapy, stemming from the fact that in the 1st instance energy absorption within the tissues is by the Compton effect and in the 2nd case by the photoelectric effect, are: (1) increased skin tolerance, (2) reduced bone absorption, (3) increase in depth dose, (4) diminished radiation sickness, and (5) simplicity of operation. As a disadvantage, possibility of injury to adjacent organs is greater with Co^{60} therapy, since skin reactions, indicative of overdosage with x-ray therapy, may be absent. Some tumors at limited skin depth, such as in the larynx, are not amenable to Co^{60} therapy because of the high exit dose. Various technical problems of Co^{60} therapy are discussed, including precise localization of the tumor, calculation of dosage, use of filters to evenly distribute radiation and prevent hot spots, immobilization and positioning of the patient, and direct dosimetry for affirmation of calculated dosage. Favorable results are described in patients with urinary bladder tumors administered 150- to 200-rad daily doses, for a total of 6000 to 8000 rads over 6 to 8 weeks. (H.H.D.)

28 BIBLIOGRAPHY OF THE BIOLOGICAL EFFECTS OF MAGNETIC FIELDS. Leroy D. Davis, Kristallo Pappajohn, Ilga M. Plavnieks, comps., and Paul E. Spiegler, ed. Federation Proc., 21: Suppl. No. 12, Pt. II, 1-38 (Sept.-Oct. 1962).

Three hundred and ninety-three pertinent recent references are included on the effects of magnetism on the human body and related aspects of biomagnetic research. (C.H.)

29 DEVELOPMENT TENDENCIES IN THE MEDICAL AREA OF ATOMIC ENERGY AND THE RADIATION PROTECTION PROBLEMS OCCURRING. L. Rausch (Philipps-Universität Marburgh/Lahn, Ger.). Med. Klin. (Munich), [55]: 1842-9(1960). (In German)

A bibliographic review is given of the development of medical research, diagnosis, and therapy using nuclear energy with emphasis on the radiation protection problems. 63 references. (J.S.R.)

30 THE SIGNIFICANCE OF SCINTIGRAPHY FOR THE DIAGNOSIS OF THYROID ILLNESSES, ESPECIALLY OF THYROID TUMORS AND TUMORS IN THE VICINITY OF THE THYROID. H. Franke and W. Borner (Universität Wurzburg, Ger.). Med. Klin. (Munich), [56]: 685-91(1961). (In German)

From a bibliographic review of some new experiences, routine scintigraphy for thyroid function testing using radioiodine assumed an extraordinary importance. This is true not only for the detection of dystrophic thyroid tissue, but also for the early detection of neoplastic thyroid alterations. A study was made to determine whether results could be predicted through the specific type of variation in the scintigrams of two types of cold nodes. (tr-auth)

31 PRELIMINARY RESULTS WITH A 2000-CURIE COBALT TELETHERAPY INSTALLATION. R. Birkner and G. Hinz (Rontgeninstitut und der Stralentherapeutischen Klinik am Stradtischen Krankenhuas Moabit, Berlin). Med. Klin. (Munich), 56: 701-5(Apr. 1961). (In German)

A review on the improved possibilities for irradiating deep-lying tumors by telecobalt therapy is given. Irradiation set-ups, especially for gynecological tumors and for bladder and bronchial tumors, are indicated. The advantages of telecobalt therapy in comparison with conventional x-ray therapy lie in the higher localized dose obtainable and the improved general tolerance. (tr-auth)

32 COLD SPRING HARBOR SYMPOSIA ON QUANTITATIVE BIOLOGY. VOLUME XXVI. CELLULAR REGULATORY MECHANISMS. Leonora Frisch, ed. Maryland, Baltimore, Waverly Press, Inc., 1962. 423p.

A symposium on cellular regulatory mechanisms was held at Cold Spring Harbor, New York, June 4th through 12th, 1961. Topics discussed include the role of desoxyribonucleic acid (DNA) in protein synthesis, the control of nucleic acid synthesis, the role of DNA in ribonucleic acid (RNA) synthesis, the role of RNA in protein synthesis, regulation of enzyme synthesis, control of enzyme activity, and control of enzyme formation and activity in animal systems. (C.H.)

Biochemistry, Nutrition, and Toxicology

33 (TID-16877) HIGH RESOLUTION AUTORADIOGRAPHIC AND MICRORADIOGRAPHIC STUDIES OF BONE AND TEETH FROM HUMAN RADIUM CASES. R. E. Rowland (Argonne National Lab., Ill.). July 1962. Contract [W-31-109-eng-38]. 5p. (UAC-6661)

Information about the uptake of radium that can be inferred from the distribution of radium in bone is discussed. As a bone containing radium is subsequently resorbed and replaced, the replacement bone also contains radium; the amount of radium depends on the radium content of the blood, which continually decreases in magnitude after exposure. Thus the amount of radium labeling in this subsequently formed bone is dependent on that time between exposure and its formation. It is shown that it is possible to determine the length of exposure to radium by the nature of the hot spots formed in the bone. Age at the time of radium acquisition can be inferred if growth in a given location can be correlated with age. The quantity of radium acquired, or at least the rate of acquisition, can be determined as a consequence of studies of those cases who acquired known quantities of radium via the intravenous route. (M.C.G.)

34 EFFECTS OF X-RAYS ON RAT LIVER: BEHAVIOUR OF ADENINE NUCLEOTIDES, WATER AND TOTAL LIPIDS. C. Agostini and Angela Sessa (Università, Milan). Intern. J. Radiation Biol., 5: 155-66(May 1962). (In English)

The effects of x irradiation on water, lipid, and adenine-nucleotide contents of the rat liver and on the incorporation in vivo of inorganic P^{32} into liver adenine nucleotides were studied. Irradiation was localized to a single hepatic lobe, the body and the remainder of the liver being shielded and used as control. Thirty min before killing at 3, 6, and 12 hr after irradiation, the animals were injected intraperitoneally with inorganic P^{32}-phosphate. Some experiments were carried out on livers of total-body-irradiated rats killed after 6 hr. A comparison of the local irradiated lobes with the shielded portion of the same livers shows that the water

content does not change, lipid content is significantly increased 12 hr after the irradiation, and three hr after irradiation an increase in AMP concentration was observed. After 6 hr inorganic P, ADP, and ATP contents are significantly increased. After 12 hr ATP concentration was raised. At any time after the irradiation the incorporation of P^{32} into nucleotides was appreciably modified, except for an increase into ADP 3 hr after local irradiation. Total-body irradiation caused a significant increase of inorganic phosphorus level. The water, lipid, and adenine-nucleotide contents were unmodified, and the incorporation of P^{32} into adenine nucleotides appeared normal. (auth)

35 BILIARY EXCRETION OF CERIUM-144 AFTER INTRAVENOUS INJECTION IN THE RAT. N. Castellino, P. Nizza, and A. Aeberhardt (Commissariat a l'Energie Atomique, Saclay, France). Intern. J. Radiation Biol., 5: 379-99(Aug. 1962). (In French)

Biliary elimination of cerium after intravenous injection of cerium-144 was studied by catheterization of the choledoch duct in Wistar rats. The curves showing elimination of bile and of cerium as a function of time are given for five different time intervals following administration of the radioelement. Elimination of cerium by the stools is compared with elimination of cerium by the bile. There is no intestinal reabsorption of cerium. Administration of a choleretic produces no change in the biliary elimination of cerium. In the bile the cerium appears to be linked with a protein. (auth)

36 COMPARATIVE STUDY OF THE METABOLISM OF CERIUM-144 AS A FUNCTION OF ITS PHYSICO-CHEMISTRY IN THE RAT. A. Aeberhardt, P. Nizza, J. Remy, and Y. Boilleau (Commissariat à l'Énergie Atomique, Saclay, France). Intern. J. Radiation Biol., 5: 217-46(July 1962). (In French)

A study of the metabolism of ionic and colloidal cerium-144 after intravenous injection in rats was carried on over a period of 275 days. The initial distribution and the redistribution during the later phases show considerable differences, particularly at the level of the hepatic tissue and bone tissue. While ionic cerium is fixed initially by the hepatocytes, excreted by the bile duct, without secondary transfer into the bone tissue, colloidal cerium is fixed by the cells of the reticulo-endothelial system; after a short period it is returned to circulation and undergoes secondary fixation in the bone tissue and transference to the hepatocytes. These results contradict the hypothesis, accepted to date, of the transformation to the colloidal state of cerium injected into the blood. They emphasize the importance of physico-chemical factors in cerium metabolism, and provide new data on the biological mechanisms involved in the metabolism of this fission product. (auth)

37 ABSORPTION OF CAESIUM 137 FROM THE GASTRO-INTESTINAL TRACT OF THE RAT. W. Moore, Jr. and C. L. Comar (Cornell Univ., Ithaca, N. Y.). Intern. J. Radiation Biol., 5: 247-54(July 1962). (In English)

The absorption of Cs^{137} from the gastrointestinal tract of the rat was studied in vivo. The data suggest that the presence or absence of food in the digestive tract affects the movement of Cs^{137} through the digestive tract and the rate of absorption. Cs^{137} was absorbed rapidly from the gastrointestinal tract of the rat. Absorption occurred from all anatomical areas investigated, the small intestine being the most important site of absorption. The stomach and caecum absorbed only minute quantities. Using Dowex 50, total endogenous secretion was estimated at approximately 24.5% of the initial dose, as measured over the first hour after injection. Taking endogenous secretion into consideration, the total amount absorbed at the end of one hour was 98.2% of the initial dose. (auth)

38 VARIATION IN THYROID FUNCTION WITH THE VARIATION IN TRACER DOSE OF ^{131}I IN THE RAT: SELECTION OF OPTIMUM TRACER DOSE. Subhas Ranjan Basu, Sunil Kumar Lahiri, and Sukhen Chaudhuri (Saha Inst. of Nuclear Physics, Calcutta). Intern J. Radiation Biol., 5: 265-71(July 1962). (In English)

Results of the present experiment show that the values of the conversion ratio both at 24th hour and 48th hour after injection vary widely according to the quantity of I^{131} administered implying that these tracer doses of radioiodine interfere with the normal function of the thyroid gland. At higher doses from 100 μc to 10 μc per rat of 70 g bodyweight the conversion ratio is found to be lower than normal. At the lower range from 0.05 μc to 0.01 μc per rat the conversion ratio is unchanged. It is interesting to note that a dose of about 0.5 μc per rat caused a significant increase in the conversion ratio, suggesting that this dose of I^{131} stimulates the thyroid gland. (auth)

39 USE OF FULLY DEUTERIATED ALGAE EXTRACTS FOR THE ISOLATION OF NUCLEIC ACIDS. Henry L. Crespi, Julius Marmur, and Joseph J. Katz (Argonne National Lab., Ill. and Brandeis Univ., Waltham Mass.). J. Am. Chem. Soc., 84: 3489-91(Sept. 20, 1962).

The composition of aqueous extracts of fully deuterated algae is discussed and the utility of such extracts for the growth of fully deuterated fastidious microorganisms is described. Fully deuterated organisms grown in this way provide an excellent source of heavy DNA. (auth)

40 SITE OF EXCHANGEABLE HYDROGEN IN CHLOROPHYLL a FROM PROTON MAGNETIC RESONANCE MEASUREMENTS ON DEUTERIO-CHLOROPHYLL a. Joseph J. Katz, Mary R. Thomas, and Harold H. Strain (Argonne National Lab., Ill.). J. Am. Chem. Soc., 84: 3587 (Sept. 20, 1962).

Proton magnetic resonance measurements were made on ordinary and deuterated chlorophyll a. The results indicate that there is only one labile hydrogen atom and that this labile hydrogen is located on the δ-bridge C atom of the porphyrin atom and not on the predicted C-10 position. (D.L.C.)

41 INCORPORATION AND DECORPORATION OF RADIOISOTOPES. H. Kriegel (Heiligenberg-Instituts, Heiligenberg/Baden, Ger.). Med. Klin. (Munich). [55]: 1833-9(1960). (In German)

A bibliographic review is given of studies on the incorporation and excretion of radioisotopes from the body. The physical properties, maximum permissible concentrations, and the biological behavior of the most important radioisotopes are described and summarized in tabular form. The effects of polyaminopolycarboxyl acids on the decorporation of radioisotopes are also described. (J.S.R.)

42 PROTEIN LOSS IN THE DIGESTIVE TRACT. H. Bennhold and H. Ott (Universitatsklinik Tubingen, Ger.). Med. Klin. (Munich), [57]: 814-20(1962). (In German)

It is possible to investigate the intestine for normal or pathological permeability by using the I^{131}-labeled polyvinyl pyrrolidon (I^{131}-PVP) test devised by R. S. Gordon, Jr. With this test, hypoproteinemia can be clarified as a loss arising in the intestine. Such a loss can be contracted by inflammation or lymphostasis. An especially large loss arises from lymphostasis and could lead to heavy edemas and discharges. The specific studies comprised groups of patients with and without pathological I^{131}-PVP tests. It is shown that the test deficiency in inflamed gastro...tes i...l

illnesses has a relation to the severity of the illness; the same is valid for the nephrotic syndrome. Plasma protein can be lost in the intestine in this illness. An example was given of the albumin loss by intestinal lymphatic vessels. The enlarged lymph vessels can be verified by autopsy in patients deceased from lymphatic leukemia. (tr-auth)

43 THE BEHAVIOR OF PYRORACEMIC ACID, 1(+) LACTIC ACID AND ALPHAKETOGLUTARIC ACID IN RAT BLOOD AFTER WHOLE-BODY X IRRADIATION. Gunther Barth, Friedrich Besenbeck, and Harald Schoen (Medizinische Universitätsklinik, Erlangen/Nuremburg). Strahlentherapie, 119: 59-64(Sept. 1962). (In German)

The increase of pyroracemic acid, α-ketoglutaric acid, and lactic acid after x-ray irradiation observed in serum of patients was tested in rats to learn, whether the amount of the x-ray dose can be measured from quantitative determinations of pyroracemic acid, lactic acid, and α-ketoglutaric acid. Total body irradiation of 147 rats with different doses and the examination of the blood at different times after irradiation did not show significant differences in comparison with the normal values. Apparently, small laboratory animals are not suitable for this problem. The determination of the products of metabolism was done with the optical test of Warburg. (auth)

44 FOODSTUFFS, EXPOSED TO IONIZING RADIATION FOR PRESERVATION, AND THEIR HYGIENIC EVALUATION. Yu. I. Shillinger. Vopr. Pitaniya, 21: 54-61(Jan.-Feb. 1962).

A review of American, British, and Soviet literature on the effect of radiations on the nutrient value and organoleptic properties of various foodstuffs and on the bacterial and other contamination of food products is presented. (OID)

45 HYGIENIC PROPERTIES OF SEVERAL FOODS STERILIZED BY γ-RADIATION. G. I. Bondarev. Vopr. Pitaniya, 21: 61-4(Jan.-Feb. 1962).

Irradiation of foodstuffs employed in the canning industry as a means of sterilization may change the chemical and organoleptic properties of the food. The organoleptic properties and toxicity of a number of foodstuffs irradiated with Co^{60} in a dose of 1,500,000 r were examined. The organoleptic properties were determined by tasting. Toxicity was tested by following the changes in body weight, composition of the elements formed in the blood, activity of same enzymes in the blood and feces (blood serum cholinesterose, blood plasma and feces alkaline phosphatase, blood catalose), and the blood sugar level in dogs fed for 11 mo on irradiated food stored for various time periods. Beef, cod fillet, green peas, and rye bread were examined. The organoleptic properties of these products changed considerably after irradiation, but no toxic effects were observed. (OID)

Fallout and Ecology

46 RADIOIODINE DETERMINATION IN RAIN-OUT. Margrit Lesigang and F. Hecht (Universität Vienna). Monatsh. Chem., 93: 369-73(Apr. 20, 1962). (In German)

On the southwestern city boundary of Wien, rain-water samples were collected on November 4 to 5 and December 5 to 6, 1961, and therein the I^{131} activity originating in preceding Soviet nuclear weapon tests was determined by gamma spectrometry. In the first case, about 2 half-life periods of radioiodine elapsed between collection and measurement; in the second case about one half-life period. In the first sample the I^{131} concentration in the freshly fallen rain water amounted to around 128 pC/l, with the second sample around 56 pC/l. Such a decline meant that the nuclear weapon tests were stopped in the meantime. The measured values were 10^2 to 10^3 lower than the accepted tolerance doses for I^{131} in drinking water. (tr-auth)

47 FALLOUT RADIONUCLIDES IN EUPHAUSIIDS. Charles Osterberg (Oregon State Univ., Corvallis). Science, 138: 529-30(Oct. 26, 1962).

Radioanalyses by gamma-ray spectrometry were carried out on 37 samples of Euphausia pacifica obtained from a network of stations off the Oregon coast. Data on euphausiids taken from this area in November 1961 and in March and April 1962 are compared to show the variation in concentration of zirconium-95 and niobium-95, ruthenium-103, and cerium-141 with time and location. A mixture of zirconium-95 and niobium-95 was the most abundant fission product noted. (auth)

Radiation Effects on Living Tissues

48 (AFSWP-809) A STUDY OF THE EFFECTS OF TOTAL AND PARTIAL BODY RADIATION ON IRON METABOLISM AND HEMATOPOIESIS. Progress Report for Period, September 1, 1955 through January 31, 1956. Vincent P. Collins, R. Kenneth Loeffler, D. A. Rappoport, and C. T. Teng (Baylor Univ., Houston, Tex. Coll. of Medicine and Jefferson Davis Hospital, Houston, Tex.). Contract DA-49-007-MD-428. 94p. (AD-270970)

Data on patients who have received total body irradiation in the course of treatment of advanced cancer are analyzed and presented in graphic form. The interpretation of the data on patients with a variety of hematopoietic disorders are presented as background for evaluating radioiron tracer studies in radiation effects. Over 700 studies on more than 300 patients were carried out to show the significance of radioiron tracer studies as an index of radiation effect. The role of radioiron tracer studies as a measure of radiation damage was evaluated in cancer patients receiving total body irradiation and limited-field irradiation. Extension of radioiron tracer studies to provide a test for residual radiation damage is described and discussed, even though a preliminary experiment failed to indicate a useful technique. Procedures are established for the identification and quantitative estimation of enzyme systems in circulating red blood cells with a view to establishing a biologic dosimeter. (auth)

49 RENAL EXCRETION OF MAGNESIUM IN THE RABBIT. C. Raynaud (Commissariat a l'Energie Atomique, Orsay, France). Am. J. Physiol., 203: 649-54(Oct. 1962).

In rabbits, after rapid intravenous injection of Mg^{28}, the plasma and urinary specific activities, corrected for transit time, are at all times in equilibrium. Injection of Mg^{28} during stop flow does not reveal any tubular zone permeable to magnesium. On the other hand, the magnesium behavior is in many ways comparable to that of a glomerular substance. These three arguments lead to the view that urinary magnesium is of essentially glomerular origin, and rule out any mechanism of tubular exchange or secretion. (auth)

50 STUDIES ON THE ELECTRONIC PARAMAGNETIC RESONANCE OF DEOXYRIBONUCLEIC ACID EXTRACTED FROM BACTERIOPHAGE T2. C. Nicolau, E. Edlinger, and H. G. Thom (Humboldt Univ., East Berlin). Arch. Roumaines Pathol. Exptl. Microbiol., 21: 405-9(June 1962).

Measurements were made on deoxyribonucleic acid (DNA) from calf thymus and from Escherichia coli T2 phage, before and after irradiation of the DNA with doses up to 5×10^6 r. The electron paramagnetic resonance spectra of na-

tive and irradiated T2 DNA showed pronounced differences, and irradiated T2 and calf DNA were also different. Native calf DNA showed resonance line centered at $g = 2.00$ and at 1800 gauss and above, whereas native T2 DNA showed no resonance lines. Irradiated T2 DNA, in comparison with irradiated calf DNA, showed a hyperfine spectral structure formed by 3 equidistant lines of equal intensity. The signal appeared to be superimposed on a larger line lacking hyperfine structure, centering about 30 gauss. It is suggested that this difference may be attributed to the presence of 5-hydroxymethylcytosine in T2 DNA in contrast to cytosine in calf DNA and that the former purine may be the site of x-ray inactivation of T2 phage DNA. (H.H.D.)

51 CONTRIBUTION TO THE STUDY OF THE PROBLEM OF THE VARIABILITY OF TUBERCLE BACILLI. Alexandrina Gaiginski, I. Roman, Natalia Stavri, and Sofia Timosca (Acad. Rumania, Jassy). Arch. Roumaines Pathol. Exptl. Microbiol., 21: 411-42(June 1962).

Development of nonvirulent, alcohol-acid resistant strains of tubercle bacilli under various chemical and physical stimuli was studied. One such attenuated strain was obtained by treatment of a virulent strain with trichloroiodopyridine at a concentration of 1% for 30 to 60 days. This strain conferred immunity in guinea pigs, except when the immunizing injections were given in mineral oil, a property also found with BCG. Ten attenuated strains were obtained from 5 virulent strains by ultraviolet or x irradiation. X irradiation was applied to 5- to 9-day cultures in doses of 1000 to 1500 r, and incubation was carried out for 30 days. Such irradiation did not modify BCG and Vallee bovine strains, nor did it alter the streptomycin, ioniazid, or p-aminosalicylate resistance of resistant virulent strains. (H.H.D.)

52 PARAMECIUM INJURY CAUSED BY THE RADIOLYTIC PRODUCTS OF WATER AT THE MOMENT OF RADIANT INTERACTION. E. G. Zinov'eva. Doklady Akad. Nauk SSSR, 145: 1389-92(Aug. 21, 1962). (In Russian)

Hydrogen peroxide is a stable radiolytic product, and the radicals H, OH, and HO_2 are short-lived radiolytic products. It was shown experimentally that no deaths resulted on suspending paramecium for 4 hours in a solution containing 9.5 γ/ml of H_2O_2. Pretreatment of paramecium with a weak H_2O_2 solution did not change its sensitivity to irradiation. However, by carrying out the irradiation of paramecium in a previously irradiated medium or in the presence of H_2O_2, it was possible to increase the reaction time of the short-lived radicals on the paramecium due to the following radical reactions: $H + H_2O_2 \rightarrow H_2O + OH$; $OH + H_2O_2 \rightarrow H_2O + HO_2$, $HO_2 + H_2O_2 \rightarrow H_2O + O_2 + OH$ and $O_2^- + H_2O_2 \rightarrow O_2 + OH^- + OH$. Experiments were carried out in order to test this hypothesis. A dose of 50 kr was given to 300 paramecia in 0.3 ml of a previously irradiated medium (50 kr) which contained 5.1 γ/ml of H_2O_2 (the final H_2O_2 content was 8.5 γ/ml after the irradiation). A dose of 100 kr was given to 300 paramecia in 0.3 ml of a freshly prepared culture medium. A dose of 50 kr was given to 300 paramecia in 0.3 ml of a H_2O_2 solution containing 5 γ/ml (final H_2O_2 content was 8.56 γ/ml). A dose of 100 kr was imparted to 300 paramecia in 0.3 ml of a fresh, culture medium. The final H_2O_2 content in the experiments with 100 kr doses was 8.38 γ/ml. The results showed that a lower irradiation dose of 50 kr, where the solutions contained H_2O_2 formed by irradiation or added to the solution, gave lower survivals of 58.0 and 67.5% respectively, as compared to survivals of 83.5 and 85.4% in experiments where the dose was twice as high (100 kr) in a fresh, culture medium. Addition of peroxide to a medium results in a significant increase in the lethal effect of the short-lived radiolytic products. (TTT)

53 THE EFFECT OF X-RAY IRRADIATION DURING VARIOUS PERIODS OF EMBRYONIC DEVELOPMENT ON THE TESTICLES OF THE SEXUALLY-MATURE MOUSE. N. I. Nuzhdin and N. N. Kuznetsova (Inst. of Genetics, Academy of Sciences, USSR). Doklady Akad. Nauk SSSR, 145: 1393-5(Aug. 21, 1962). (In Russian)

White, female mice 2.5 to 3 months in age were given a single 200 r dose of x rays on the 12th to 19th day of pregnancy. Male members of the litter were killed on attaining an age of 45 days, and testicles were weighed and subjected to histological analysis. Transverse slices of the seminal canals (100) were selected, and a quantitative estimate was made of the different types of embryonic cells: spermatogonia, prespermatocytes, spermatocytes, spermatids, and sperms. The percent of barren canals in the testicles was also used as a quantitative indicator of the amount of damage to the testicle. The maximum decrease in weight of the testicle, which serves as a good indicator of the degree of damage caused by the radiation, was observed for irradiation on the 16th day of embryogenesis. The weight of the testicle of a 45 day old animal was only 20 mg as compared to a testicle weight of 125 mg in the controls. The histological results showed that the fetus undergoes extensive damage with irradiation on the 15th to 18th days of embryonic development. Maximum damage was observed for irradiation on the 16th day of embryogenesis. Active spermatogenesis was taking place in all the canals of the testicles of the 45 day control mice. No barren canals were observed in the controls. The percent barren canals was 0.14% for irradiation on the 12th day of pregnancy. There was a gradual increase in the percent barren canals for irradiation on the 13th, 14th, and 15th days with a maximum of 96.1% on the 16th day of embryogenesis. Then, the percent barren cells gradually decreased to 6.8% barren canals on the 19th day of embryonic development. It was proved that a dose of 200 r causes severe damage to the gonads, especially when the irradiation is performed on the 14th to 17th day of embryogenesis. (TTT)

54 I. THE UPTAKE OF RADIOACTIVE IRON IN RED CELLS OF THE RHESUS MONKEY AFTER WHOLE-BODY IRRADIATION BY X-RAYS. C. W. Gilbert, Edith Paterson, and Mary V. Haigh (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Intern. J. Radiation Biol., 5: 1-7(Apr. 1962). (In English)

High-specific-activity Fe^{59} was used to study changes in the hemopoiesis in Rhesus monkeys following whole-body irradiation at LD_{50} levels. A technique of giving repeated intravenous injections of Fe^{59} was used, and this approximated to a continuous intake of labelled iron. It is shown that for about 20 days after the irradiation no new red cells enter the circulation and also that during this period the plasma-clearance rate for iron is low. When erythropoiesis recommences, most of the tracer iron which has not previously been used becomes available for incorporation into new red cells. (auth)

55 II. RED-CELL AND PLASMA-VOLUME CHANGES IN THE RHESUS MONKEY AFTER WHOLE-BODY IRRADIATION BY X-RAYS. C. W. Gilbert, Edith Paterson, Mary V. Haigh, and R. Schofield (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Intern. J. Radiation Biol., 5: 9-23(Apr. 1962). (In English)

Red-cell volumes were measured in the Rhesus monkey using a P^{32} label, and the plasma volumes deduced from the red-cell volume and the hematocrit. The plasma volume

decreased slowly for the first 11 days after irradiation and then increased rapidly until death in the monkeys which died from the irradiation. In the survivors the increase was less marked and continued only for a few days, returning to its original value after some weeks. The red-cell volume showed a steady decrease until death or until the onset of hemopoietic recovery at about 21 days. The rate of decrease showed no difference between survivors and non-survivors and ranged from 2.4 to 4.7% per day. All monkeys were given Fe^{59} 14 days before irradiation, so that at irradiation the Fe^{59} tag was carried by red cells which had recently emerged into the circulation. Changes in the Fe^{59} concentration showed a relatively greater loss of the older red cells, and no difference was noted between survivors and non-survivors. The rate of loss of the red-cell volume can be divided into two parts: an aging loss of about 1.3% per day, and a loss due to the irradiation of about 2.5% per day, which removes red cells of all ages. (auth)

56 III. THE MECHANISM OF DESTRUCTION OF RED CELLS OF THE RHESUS MONKEY AFTER WHOLE-BODY IRRADIATION BY X-RAYS. Edith Paterson, C. W. Gilbert, and Mary V. Haigh (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Intern. J. Radiation Biol., 5: 25-31(Apr. 1962). (In English)

Young red cells carrying a Fe^{59} label were prepared in a donor monkey, and aliquots were transfused into monkey A after, and into monkey B before, 520 rads irradiation, and into monkey C, which was not irradiated. The red-cell volumes and the Fe^{59} concentrations were measured. A small loss of the donor cells was noted in the control animal although no cross-agglutination can be shown in our Rhesus monkeys. After making allowance for this loss, no differences were shown in the rate of loss of the donor cells in monkeys A and B, and the losses corresponded to those measured, in previous experiments, of the animals' own red cells of the same age. Thus the loss of red cells after irradiation seems to be due not to a direct damage of the red cells but to an effect of the radiation mediated via the irradiated animal. (auth)

57 EFFECTS OF IONIZING RADIATION ON A SLIME MOULD WITH SYNCHRONOUS MITOSIS. Oddvar F. Nygaard (Univ. of Michigan, Ann Arbor) and Sophie Guttes. Intern. J. Radiation Biol., 5: 33-44(Apr. 1962). (In English)

In the slime mould, Physarum polycephalum, the nuclei of a single plasmodium exhibit synchrony of division. The synthesis of DNA occurs very shortly after nuclear division, resulting in an extremely short G_1- and a relatively long G_2-period of interphase. When a single plasmodium was exposed to 9000 r of x radiation during G_2, a delay of division was observed; the duration of this delay was independent of the time within the G_2-period at which the irradiation occurred. From the effects observed with asynchronous shake-cultures of the mould it appears that irradiation during G_2 causes a cessation of the onset of DNA-synthesis and a subsequent resumption of the synthesis, which seems related in time to the delay of mitosis. Irradiation during prophase caused a greatly increased delay in nuclear division, and irradiation during the reconstruction period after division delayed the subsequent mitosis much more than did exposure during G_2. Exposure of the mould to 23,000 rep of Co^{60} γ radiation during mitosis and the subsequent period of DNA-synthesis prevented further divisions of the nuclei. In this latter case the replication of DNA was apparently not hindered by irradiation, suggesting that the process of DNA-synthesis per se is not sensitive to radiation and that mitosis and DNA synthesis can be dissociated by irradiation. (auth)

58 TUMOUR-GROWTH AND CELL-VIABILITY OF IRRADIATED EHRLICH ASCITES CARCINOMA IN THE MOUSE. G. Silini, S. Hornsey, and M. Ebert (Hammersmith Hospital, London). Intern. J. Radiation Biol., 5: 45-57(Apr. 1962). (In English)

Growth curves were obtained for a tetraploid strain of the Ehrlich ascites tumor of the mouse, both untreated and after irradiation. Higher total cell-counts were obtained when viable and heavily-irradiated cells were mixed. This can be explained by the multiplication of the heavily-irradiated cells (which was demonstrated), rather than by stimulation of the growth of the viable fraction. The method as a means of assessing cell viability after irradiation is compared with a cell-titration technique. (auth)

59 STUDIES ON THE DURATION OF DNA-SYNTHESIS AND MITOSIS IN IRRADIATED AND REGENERATING EPIDERMIS CELLS IN MICE, BY MEANS OF TRITIUM-LABELLED THYMIDINE. Finn Devik (State Inst. of Radiation Hygiene, Montebello, Oslo). Intern. J. Radiation Biol., 5: 59-66(Apr. 1962). (In English)

The fraction of labeled mitoses was recorded in normal, irradiated, and regenerating epidermis of the skin of a strain of hairless mice at short intervals after injection of tritiated thymidine. Analysis of the results indicates that the G_2 phase could be accomplished in about one hour. The time spent in mitosis was about one hour for some cells, while the S phase required about 6 hours. The total mean time spent in the S + G_2 + M phase appears remarkably similar in normal, irradiated, and regenerating cells. This indicates that differences in the turnover-time of these cells are mainly related to changes in the G_1 phase. Under conditions of rapid growth the G_1 phase seems to be extremely short. Analysis of differential counts of labelled mitoses indicates considerable variations in the duration of the S, the G_2 and the M phases. A number of cells appear to spend several hours in mitosis. (auth)

60 THE ORIGIN OF TAURINE EXCRETED IN THE URINE AFTER WHOLE-BODY IRRADIATION. G. M. Watson (Australian Atomic Energy Commission Research Establishment, Sutherland, New South Wales). Intern. J. Radiation Biol., 5: 79-83(Apr. 1962). (In English)

Irradiated rats excrete an excess of taurine in the urine during the first day after exposure. The injection of a large dose of cortisone has a similar effect. If rats are given smaller injections of cortisone daily for a week, subsequent irradiation no longer increases the excretion of taurine. Since both cortisone and ionizing radiation readily destroy lymphocytes, it is thought that the radiation-induced excretion of taurine may be wholly accounted for by damage to lymphoid tissues, which contain a high concentration of taurine. The amount of taurine excreted after irradiation may provide an estimate of the total amount of lymphoid tissue in the body. (auth)

61 THE EFFECTS OF X-IRRADIATION ON THE BIOSYNTHESIS OF HAEMOGLOBIN. III. EXPERIMENTS WITH PORPHOBILINOGEN-3,5-^{14}C. A. M. Dancewicz, K. I. Altman, and K. Salomon (Univ. of Rochester, N. Y.). Intern. J. Radiation Biol., 5: 85-92(Apr. 1962). (In English)

The degree of incorporation of porphobilinogen-3,5-C^{14} (PBG) into hemin was determined in bone-marrow homogenates of rabbits after 600 r, 800 r, or 1000 r of whole-body x irradiation. The time-periods studied after exposure to x rays ranged from 30 min to 48 days. In parallel with the capacity of bone-marrow to synthesize hemin, DNA-concentration and hemin-concentration were determined. The capacity of bone-marrow homogenate to synthesize hemin increased significantly on the first, seventh, and

fourteenth day after exposure to 600 r and on the seventh and fourteenth day after exposure to 800 or 1000 r. After exposure to 800 r, similar patterns of radiation-induced changes were found when PBG or DAL were used as precursors. These patterns differed markedly from those observed when glycine was used as a precursor. (auth)

62 RADIATION DAMAGE AND THE SURFACE PROPERTIES OF EHRLICH ASCITES-TUMOUR CELLS. I. PERMEABILITY TO TAGGED PROTEIN. D. Thomason and D. D. Porteous (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Intern. J. Radiation Biol., 5: 93-9(Apr. 1962). (In English)

Mice bearing Ehrlich ascites tumors were injected intraperitoneally with I^{131}-tagged protein at intervals after a whole-body dose of 1400 rads of x rays. This lethal dose of x rays had no effect on penetration of the protein into the tumor cells at intervals of 4, 24, and 48 hours, and immediately after irradiation. Transport of the protein from the peritoneal cavity to the rest of the body of the mouse was, however, progressively retarded after irradiation. (auth)

63 SCHULTZ-DALE REACTION IN THE DEMONSTRATION OF RADIATION-INDUCED CHANGES OF TISSUE ANTIGENIC COMPOSITION. S. Keckeš, V. Stanković, and N. Allegretti (Institute 'Ruder Bošković', Zagreb). Intern. J. Radiation Biol., 5: 123-8(May 1962). (In English)

An experiment was conducted on the immunization of guinea-pigs with homogenized rat tissues (spleen, intestine, and testes) mixed with Freund's adjuvant. Tissues were obtained one day after lethal whole-body x-ray exposure. Anaphylactic sensitivity, as demonstrated by the Schulz-Dale reaction after desensitization in vitro with the blood sera of normal rats, showed that the spleen of irradiated animals has some antigenic compounds which are not present in the blood sera of normal rats, but which exist in the sera of irradiated rats. Muscle organs from intestinal tissue sensitized animals were much less specifically activated, and testicular tissue did not manifest any antigenic specificity. It is proposed that there is no correlation between the tissue radiosensitivity and the radiation-induced change of its antigenicity. (auth)

64 ANAPHYLACTIC HYPERSENSITIVITY (SCHULTZ-DALE REACTION) IN GUINEA-PIGS IMMUNIZED WITH AUTOLYZED SPLEEN OR SPLEEN FROM X-IRRADIATED RATS. V. Stanković, S. Kečkeš, and N. Allegretti (Institute 'Ruder Bošković', Zagreb). Intern J. Radiation Biol., 5: 129-32(May 1962). (In English)

Guinea-pigs were injected with homogenized spleens of normal or irradiated rats (one day after 1000 r) or with autolyzed spleens of normal rats. Schultz-Dale reactions after different desensitizations in vitro with sensitizing materials were determined. The experimental data provide additional evidence for the existence of some new antigenic component(s) in irradiated spleen. This component is not radiation specific, for it is present in autolyzed spleen too. Some preliminary results are given, showing that previous immunization with such tissues renders the rats more susceptible to the lethal effect of irradiation. (auth)

65 THE KINETICS OF X-RAY SURVIVAL OF MAMMALIAN CELLS IN VITRO. M. A. Bender and P. C. Gooch (Oak Ridge National Lab., Tenn.). Intern. J. Radiation Biol., 5: 133-45(May 1962). (In English)

The shapes of the x-ray survival-curves of two tissue-cultured mammalian cell-lines were studied, using machine methods for data fitting. It was found that the survival data fit a multi-process cell-killing model better than the single-process model proposed by other workers. In addition, the effects of the mode of plating and the time of irradiation were studied. Although both affect the sensitivity of the cells, no effect on the shapes of the survival-curves was demonstrated. (auth)

66 STUDIES ON CELL-SURVIVAL OF IRRADIATED EHRLICH ASCITES TUMOUR. III. A COMPARISON OF THE X-RAY SURVIVAL CURVES OBTAINED WITH A DIPLOID AND A TETRAPLOID STRAIN. G. Silini and S. Hornsey (Hammersmith Hospital, London). Intern. J. Radiation Biol., 5: 147-53(May 1962). (In English)

The survival curves obtained with a hypo-diploid Ehrlich ascites carcinoma after irradiation with x rays in either oxygen or nitrogen are compared with those previously reported for a near-tetraploid tumor. The radiosensitivity of the two cell-lines, as defined by the slope of the exponential part of the survival curves, is the same when the irradiations are in oxygen. Anoxia lowers the radiosensitivity of the diploid tumor by a factor of 2.7 and that of the tetraploid tumor by 3.1. The extrapolation of the exponential part of the survival curves to zero dose results in an intercept of 2.4 for the diploid tumor compared with approximately 10 for the tetraploid tumor. The significance of a high extrapolation number in the fractionated radiation treatment of spontaneous tumors is discussed. (auth)

67 THE APPARENT PEROXIDE CONTENT OF IRRADIATED AND ALARMED MICE. V. J. Horgan and J. St. L. Philpot (Medical Research Council, Harwell, Berks, Eng.). Intern. J. Radiation Biol., 5: 167-81(May 1962). (In English)

Technical improvements are described in the study of apparent peroxide in x-irradiated mice. Hairless mice, 6 weeks old, were fed on peroxide-free food and irradiated with precautions against alarm. Oxygen was excluded during extraction and estimation of peroxide. With radiation doses up to 6000 r the mean ionic yield of apparent peroxide was 28. Without radiation the mean apparent peroxide was raised by alarm and by consumption of normal food which contained peroxide. The mean apparent peroxide did not change significantly between 1 min and 16 hr after irradiation. It was unaffected by a protective dose of AET. (auth)

68 X-IRRADIATION AND DIPHOSPHOPYRIDINE NUCLEOTIDE (DPN) LEVELS IN ASCITES-TUMOUR CELLS AND LIVER TISSUE OF MICE. M. Schneider, F. O'Bourke, and H. M. Redetzki (Univ. of Texas Medical School, Galveston). Intern. J. Radiation Biol., 5: 183-9 (May 1962). (In English)

Mice with Ehrlich's ascites tumor received total-body x irradiation with 900 to 5000 r. Concentrations of oxidized DPN were analyzed enzymatically with yeast alcohol dehydrogenase in liver and tumor-cell homogenates 2 hr and 12 hr after irradiation. After 5000 r, tumor cells and liver exhibited but little decrease of DPN, 5% and 7% respectively at 2 hr, and 12% at 12 hr. When animals were irradiated before or after intramuscular administration of nicotinamide (170 mg/kg), significant alterations of steady-state concentrations of DPN were observed. After irradiation, average decreases of DPN in tumor cells and liver were 22% and 27% respectively (2 hr) and 16% and 17% (12 hr). It follows that x irradiation within the stated dose-range moderately inhibits DPN-synthesis or activates DPN-breakdown. The effect is compensated at normal cellular concentrations of DPN, but is demonstrated if DPN-synthesis is activated by administration of nicotinamide. (auth)

69 EFFECT OF X-RAYS ON THE DURATION OF LIFE OF THE RICE WEEVIL, SITOPHILUS ORYZAE L.

M. A. Mahrous and Z. M. F. Rostom (Ain Shams Univ., Cairo). Intern. J. Radiation Biol., 5: 191-3(May 1962). (In English)

Data are tabulated on the effects of doses of x radiation ranging from 1,000 to 20,000 r on the life span of the adult male and female rice weevil, Sitophilus oryzae. Females lived longer than males in 12 of 14 irradiated groups. Results are discussed in terms of application in radiation killing of these weevils. (C.H.)

70 EFFECT OF CALCIUM SALTS ON THE RADIOSENSITIVITY OF RAT THYMOCYTES. D. K. Myers and Donna E. DeWolfe (Atomic Energy of Canada Ltd., Chalk River, Ont.). Intern. J. Radiation Biol., 5: 195-7(May 1962). (In English)

A substantial increase in the survival of irradiated thymocytes, isolated from thymus glands of young rats, resulted from the addition of Ca salts to the suspension medium. The addition of 0.01 M Ca increased survival from 34 to 72% after exposure to 70 r x radiation, and from 0 to 33% after exposure to 4,000 r. Similar results were observed when the Ca was added before or after irradiation. A number of other compounds were tested in a similar manner but their effects were much less striking. These include sodium gluconate or glucuronate, magnesium salts, and other compounds. It was concluded that the protection afforded by Ca ions against radiation death of thymocytes is fairly specific. (C.H.)

71 COMPARATIVE ASPECTS OF ACUTE RADIATION MORTALITY IN BIRDS. S. Phyllis Stearner and Sylvanus A. Tyler (Argonne National Lab., Ill.). Intern J. Radiation Biol., 5: 205-15(July 1962). (TID-14627). (In English)

Adult parakeets and pigeons, given doses of Co^{60} γ-rays in the 30-day lethal range, showed a peak of mortality at 9 to 11 days; and the early mortality (0 to 2 days after exposure), which is characteristic of the chicken, was not seen. Bone-marrow aplasia was the principal histological finding. When the duration of the exposure was increased from 4 to 480 min, there was a progressive decrease in dose effectiveness, but further increase of the exposure time to 1440 min led to no further decrease in dose effectiveness. These data are described in terms of time-dependent (reversible) and time-independent (irreversible) processes. A linear reversal of the time-dependent injury processes is in agreement with available data. The time constant associated with the reversible process in the parakeet and pigeon ($\tau = 295 \pm 25$ min) is in close agreement with the value reported earlier for the chick. (auth)

72 DOSE-EFFECT OF X-RAYS ON ISOLATED IN VITRO ADRENAL GLANDS OF 5-DAY-OLD RATS, TRANSPLANTED INTO THE ANTERIOR EYE-CHAMBER OF ADRENALECTOMIZED INFANTILE HOSTS. Petar N. Martinovitch, Desanka Pavitch, Miroslava Pavlovitch-Hournac, and Nada Živkovitch (Institute of Nuclear Sciences 'Boris Kidrič', Beograd, Yugoslavia). Intern. J. Radiation Biol., 5: 255-64(July 1962). (In English)

Doses of x rays above 10,000 r applied to isolated and irradiated in vitro adrenal glands in covered petri dishes will kill all the cells of adrenal cortex of 5-day-old rats. This is evident when x-irradiated glands are transplanted into non-irradiated adrenalectomized rats immediately after irradiation. Doses of 5000 r and 7000 r will occasionally spare a few cells of the germinative zone of the cortex. These cells, though unable to divide and heavily damaged, are still capable of some functional activity, as demonstrated by the length of survival of their respective hosts. The dose of 3000 r will destroy the inner layers of the cortex, but the germinative layer, though clearly affected by the rays, will show considerable mitotic activity of cells in about 50% of treated glands. Adrenalectomized recipients with recovered grafts retain their sexual potencies unimpaired. Evidence has been obtained showing that the cells of the zona glomerulosa of the cortical layer and of the adrenal capsule exposed in vitro to 3000 r in a covered petri dish and grafted into non-irradiated adrenalectomized rats are capable of preserving their capacity to divide mitotically, which the cells of irradiated and cultivated in vitro glands or the cells of the gland in situ of a whole-body irradiated animal cannot do. (auth)

73 ELECTRO-SHOCK SEIZURE RESPONSES TO RESERPINE AND IPRONIAZID AFTER X-IRRADIATION IN RATS. Fred Rosenthal and Paola S. Timiras (Univ. of California, Berkeley). Intern. J. Radiation Biol., 5: 273-82 (July 1962). (In English)

Reserpine (2 mg/kg) and iproniazid (100 mg/kg) were administered to adult rats after single doses of 500 r whole-body x irradiation. Threshold for minimal electroshock seizures and pattern of maximal electro-shock seizures were studied under experimental conditions of drug injection and irradiation. X irradiation lowers threshold for minimal convulsions which suggests an increased brain excitability; it also shortens maximal tonic–clonic convulsions, which in turn can be interpreted as a more rapid than normal onset of neutral fatigue. Reserpine has a synergistic effect on the post-irradiation fall in threshold while counteracting the shortening of the maximal seizure. Iproniazid has a less marked synergistic effect on the fall in threshold after irradiation and produces no significant change in the pattern of maximal convulsions. These results were interpreted in terms of a direct action of irradiation, reserpine, and iproniazid on brain function involving mechanisms related to brain serotonin. (auth)

74 THE INDUCTION OF MUTATIONS IN SPERMATOCYTES OF DROSOPHILA MELANOGASTER WITH X-RAYS. Ann C. Chandley (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Intern. J. Radiation Biol., 5: 305-22(Aug. 1962). (In English)

F_1 males of Drosophila melanogaster were irradiated with 1,000 rads x rays and then mated at the rate of two females per male per day for eight days following the irradiation. The frequencies of dominant lethals, translocations, sex-linked lethals, deleted X's and induced crossing-over in the male were estimated in matings on days 5, 6, 7, and 8 following treatment. It is claimed that the sperm used in matings over these four sampling days was in the spermatocyte or early spermatid stage at the time of irradiation. Thus the frequencies of mutations recorded will give an estimate of the relative sensitivities of these various stages of germ cell development to x rays. Results show that sex-linked lethals and translocations follow similar patterns, reaching a peak on day 5, the level then dropping off through days 6 and 7 to a low value on day 8. Dominant lethals show an increase from day 5 to a high level on day 6 which is maintained over days 7 and 8. Deleted X's and induced crossing-over increase from day 5 through days 6 and 7 to reach a peak on day 8. The relationship between the type of aberration studied and the sensitivity pattern of the treated germ-cells is discussed. (auth)

75 DNA-SYNTHESIS IN NUCLEI ISOLATED FROM REGENERATING RAT LIVER AFTER WHOLE-BODY IRRADIATION. S. M. Lehnert and S. Okada (Univ. of Rochester, N. Y.). Intern. J. Radiation Biol., 5: 323-9(Aug. 1962). (In English)

Incorporation of tritiated thymidine into DNA of nuclei isolated from the regenerating livers of rats given 800 r of whole-body radiation 24 hours after partial hepatectomy has been studied in the presence of a DNA-synthesizing enzyme system. Immediately after irradiation no difference in incorporation was demonstrable between irradiated and non-irradiated liver nuclei. With increasing time after irradiation, up to 24 hours, incorporation became progressively depressed. At 24 hours after irradiation, incorporation was depressed to the same extent after doses of 200 to 3000 r. Incorporation into nuclei of liver from non-hepatectomized rats was unaffected 24 hours after a dose of 800 r. In contrast to the findings with isolated nuclei, DNA extracted from irradiated regenerating liver, 24 hours after a dose of 800 r, incorporated tritiated thymidine to the same extent as did DNA extracted from non-irradiated regenerating liver. Mechanisms by means to which these findings may be explained are discussed. (auth)

76 EFFECTS OF IRRADIATION ON THE MEDITERRANEAN MEAL MOTH, EPHESTIA KUEHNIELLA ZELLER, CULTURED ON ^{89}Sr-SPIKED FOOD. Howard E. Erdman (General Electric Co., Richland, Wash.). Intern J. Radiation Biol., 5: 331-8(Aug. 1962). (In English)

Ephestia kuehniella Zeller was cultured on corn-meal spiked with Sr^{89} at concentrations of 0, 0.1, 0.3, 1.0, 3.0, and 5.0 μc/g of food. As the environmental radiation was increased, the adults which were subjected throughout their life-cycle produced progressively fewer progeny. 5.0 μc Sr^{89}/g food approaches the critical level which will inhibit population development. Life-span of the adults was not influenced by the experimental conditions. Delayed development occurred at all isotopic concentrations employed. The radiostrontium-content of females at the end of their life-cycle was half that of males. Twenty-four hours after eclosion, the radioactivity of the female moth was equal to, or greater than, that of corresponding males. Reproductive metabolism is offered in explanation. At the two highest culture levels (3 and 5 μc Sr^{89}/g), the increased number of males (homogametic sex) over females (heterogametic sex) is consistent with the radiation genetic effect of induced recessive lethals. No selective radiation effect upon the sexual capacity of gametes of the F_1 was indicated, since the subsequent F_2 sex ratio was 1:1. (auth)

77 EXPERIMENT AND DISCUSSION ON LEUKAEMOGENESIS BY CELL-FREE EXTRACTS OF RADIATION-INDUCED LEUKAEMIA IN MICE. R. Latarjet and J-F. Duplan (Institut du Radium, Paris). Intern J. Radiation Biol., 5: 339-44(Aug. 1962). (In English)

We have confirmed that cell-free extracts of radiation-induced leukemia in C57 Bl mice contain an agent (virus) which produces lymphoid leukemias when injected into isologous new-born or young adult non-irradiated mice. Therefore C57 Bl mice naturally harbor this virus and are not immune to it. This virus is inactive on AkR mice: it appears different from the Gross virus. From the discussion it is concluded that several processes cooperate in radio-leukaemogenesis. Some may concern the concentration of the virus; some others the competent cells of the host. (auth)

78 THE EFFECT OF X-RADIATION ON THE VISUAL CELLS IN ORGAN CULTURES OF MATURE GUINEA-PIG RETINA. D. R. Lucas (Medical Research Council, Harwell, Berks, Eng.). Intern. J. Radiation Biol., 5: 345-52(Aug. 1962). (In English)

The effect of x radiation on the survival of visual cells in organ cultures of guinea-pig retina was measured. Over the measurable range of response the relationship between survival and dose was linear. With oxygen as gas phase, the dose resulting in 50% survival (D_{50}) was 2400 rads; with air as gas phase, the D_{50} was between 2550 and 2630 rads; and with nitrogen as gas phase, the D_{50} was 3370 rads. The small difference in response to radiation when oxygen was present cannot be accounted for by an oxygen gradient in the tissue. (auth)

79 THE EFFECT OF IONIZING RADIATION ON PSEUDOMONAS AERUGINOSA AT VARIOUS OXYGEN-CONCENTRATIONS. A. A. van Soestbergen (National Defence Research Organization T.N.O. Rijswijk (Z.H.), Netherlands). Intern. J. Radiation Biol., 5: 353-67(Aug. 1962). (In English)

The effect of x irradiation at various oxygen-concentrations was examined for a strain of Pseudomonas aeruginosa. The maximum ratio for enhancement of the effect by oxygen is 3.0. The data confirm the relationship between the slope of the dose–survival curve and the oxygen-concentration established by Howard-Flanders and Alper (1957) for Escherichia coli and Shigella flexneri. The fractions of bacteria surviving a specified dose, plotted against the logarithm of the oxygen-concentration, also follow approximately a cumulative normal curve. The exponential function corresponding with this curve and the relationship established by Howard-Flanders and Alper fit the data equally well, as is demonstrated by statistical analysis. The 50 per cent activity value for oxygen decreases with increasing radiation dose. The experimental evidence indicates that the sensitivity of the bacteria to x irradiation increases with the dose. It is proposed that products formed inside the cell by irradiation in the presence of oxygen interact with a receptor site which is sensitized by the irradiation. The assumed sensitive site persists for at least 3 min after cessation of irradiation, causes no lethal damage to the organism, and does not react with oxygen. (auth)

80 THE EFFECT OF DOSE-RATE AND FRACTIONATION ON ACUTE MORTALITY IN X-IRRADIATED MICE. PART II. J. A. H. Brown, M. J. Corp, and R. H. Mole (Medical Research Council, Harwell, Berks, Eng.). Intern. J. Radiation Biol., 5: 369-77(Aug. 1962). (In English)

Changing the exposure time from 15 min to less than 1 min and the dose-rate from 54 to 1100 rads/min did not reduce the $LD_{50/30}$ of mice by more than a few per cent. Changes in the uniformity of tissue dose, as by changing the direction of the x-ray beam, were quantitatively much more important. The effect of increasing exposure time from 6 to 36 hours with continuous irradiation was compared with other exposures spread over similar periods of time but divided into 2, 4, or 18 equal fractions, each at a relatively high dose-rate. Neither with continuous nor with fractionated exposures did the $LD_{50/30}$ increase indefinitely as overall exposure time was prolonged. The rapid phase of decay of radiation damage appeared to stop early, at 6 hours, after a single dose but not until after 18 hours of prolonged exposure. (auth)

81 SPECIFICITY OF ENCEPHALITOGEN-INDUCED INHIBITION OF EXPERIMENTAL ALLERGIC ENCEPHALOMYELITIS (EAE) IN THE GUINEA PIG. Cheng-Mei Shaw, Ellsworth C. Alvord, Jr., Willson J. Fahlberg, and Marian W. Kies (Univ. of Washington, Seattle). J. Immunol., 89: 54-61(July 1962).

It was found that prevention of EAE by intradermal injections of encephalitogenic extracts in water-in-oil emulsion given before the challenge by vaccine is more effective than suppression by injections given after the challenge. Prevention is much more sensitive than suppression, effec-

tive amounts being measured in g rather than mg, and is specifically related to the encephalitogenic potential of the extract. Since no circulating antibodies to the encephalitogen could be detected in either protected or unprotected guinea pigs by complement-fixation, tanned red cell, or gel diffusion techniques, the effects of whole-body x irradiation were sought as an indirect check on the validity of these negative observations. With 250 r 1 day before the first of the inhibiting injections and 10 days before challenge, 75% of the animals died before EAE could develop, but the 3 remaining unprotected guinea pigs became paralyzed at 11, 12, and 13 days and the 4 remaining protected ones at 1, 15, 22, and 24 days after challenge. Thus, with the exception of the single animals dying only 1 day after challenge, an unusual and unexplained result, the irradiated animals behaved almost exactly as their respective unirradiated controls. The resistance to the effects of whole-body x irradiation suggests that inhibition of EAE, like EAE itself, is due to the mechanisms underlying delayed-type hypersensitivity. (H.H.D.)

82 TRANSPLANTABILITY OF AN X-RAY-INDUCED AND A VIRUS-INDUCED LEUKEMIA IN ISOLOGOUS MICE INOCULATED WITH A LEUKEMIA VIRUS. Leo Sachs (Weizmann Inst. of Science, Rehovoth, Israel). J. Natl. Cancer Inst., 29: 759-64(Oct. 1962).

Inoculation with Moloney leukemia virus (MLV), but not with polyoma virus (PV) or culture fluid from an x-ray-induced leukemia (RL), inhibited the growth of isologous transplants of an MLV-induced leukemia in C57BL/6 mice. No inhibitory effect of inoculation with MLV or RL fluid was found on the growth of isologous transplants of an x-ray-induced leukemia. Inoculation with MLV also did not inhibit the growth of isologous transplants of a PV-induced tumor. The results indicate that the MLV-induced leukemia has acquired a new cellular antigen; that this antigen is different from the new cellular antigen in PV-induced mouse tumors; and that the MLV-induced antigen does not seem to be present in the x-ray-induced leukemia. The new antigen was maintained in the MLV-induced leukemia for at least 64 transplant generations. It is stressed that such experiments with leukemia provide a simple method for a comparison of new antigens induced by the known leukemia viruses and new antigens in leukemias induced by physical and chemical agents. (auth)

83 DETERMINATION OF THE DOSES DELIVERED TO AN ORGAN CONSECUTIVELY TO A UNIC ABSORPTION. G. Vacca, A. Garner, and H. Jammet. J. Radiol., Electrol. Med. Nucl., 43: 489-97(Aug.-Sept. 1962). (In French)

The determination of the dose delivered to an organ after absorption of a radioisotope has to take in account, among other factors, the duration of inhalation or ingestion and the distribution of irradiation in the course of the time. A mathematical formula to be used for such a determination is given. A classification of the elements according to their toxicity is included. It appears that classification based on weights is of higher practical value for radioactive danger. Of course, a definitive classification will also take in account the chemical toxicity, a fact that will probably bring some modifications in the relative position of some bodies. (auth)

84 TREATMENT OF LEUKEMIAS WITH RADIOPHOSPHORUS(P^{32}). M. H. Lee, J. Y. Kim, W. Hyon, and S. K. Kim (Seoul National Univ., Korea). Korean J. Internal Med., 5: No. 1, 53-9(1962).

Clinical symptoms are described for two cases of chronic myelocytic leukemia and one case of acute myelocytic leukemia following treatment with radiophosphorus. The general symptoms were greatly improved with the reduction of leukocytes and spleen size in all cases following the administration of P^{32}. In each case, the clinical and laboratory data following the treatment are discussed and evaluated. (auth)

85 GAMMA RADIATION INJURY FROM EXTERNAL APPLICATION OF THORIUM X. C. G. Schirren (Universitlit Munich). Med. Klin. (Munich), [55]: 7-8 (1960). (In German)

Extensive measurements in the vicinity of areas treated with ThX lacquer showed a much higher γ radiation dose than had been previously assumed. The values found permit an external application of ThX only when the gonad dose can be sufficiently reduced by shielding or when the patient is past child bearing. (J.S.R.)

86 THE RELATIONSHIP BETWEEN THE RADIATION BURDEN IN MILD GYNECOLOGICAL ILLNESSES AND THE ORIGIN OF MALIGNANT TUMORS. D. Hofmann and E. Kuenzler (Universitlts-Frauenklinik, Giessen, Ger.). Med. Klin. (Munich), [55]: 68-72(1960).

With the present state of knowledge, a definitive decision on the presence or extent of a tumor-inducing effect of ionizing radiation used in the treatment of mild gynecological illnesses cannot be made. Classification of the existing literature shows that the debatable causal relationship between irradiation of genital tissues and later tumor growth is probably so low that it should not be considered when other factors indicate radiotherapy. (tr-auth)

87 X RADIATION AND RADIOACTIVE MATERIALS AS THE CAUSE OF PROFESSIONAL INJURY WITH SPECIAL CONSIDERATION OF THEIR CARCINOGENIC EFFECT. K. Humperdinck (Dozent flir Arbeitsmedizen, Ruhrknappschaft Bochum, Ger.). Med. Klin. (Munich), [55]: 1128-30(1960). (In German)

A bibliographic review is made of the incidence of radioinduced illnesses and of genetic damage in the offspring of radiologists. The types of radioinduced illnesses, the difference in hazards between radiation and radioisotopes, and the establishment of tolerance levels are discussed. 25 references. (J.S.R.)

88 RADIATION DAMAGE TO GROWING BONES. W. Oelssner (Universitlitsklinik Leipzig). Med. Klin. (Munich), [55]: 1819-24(1960). (In German)

Because of the greater radiation absorption in bone than in soft tissue, bones suffer more damage from ionizing radiation. Bone damage cannot always be prevented in high-dose radiotherapy. The relatively greater significance is because of osteoradionecroses of the lower jaw following lower jaw osteomyelitis and because of osteoradionecroses of the hip joint. Of the latter, the radioinduced leg cervical fracture is the best known. The x-ray symptoms, clinical path, treatment, and prevention possibilities of the most serious osteoradionecroses are discussed. The use of ultra-hard beams (cobalt guns or electron accelerators) in addition to other precautions plays an essential role in prophylaxis. (tr-auth)

89 THE QUESTION OF CANCER PRODUCTION BY IONIZING RADIATION. E. G. Mayer (Universitlit Vienna). Med. Klin. (Munich), [55]: 1824-30(1960). (In German)

Cancers induced by ionizing radiation are based on tissue damage in which the vascular system and connective tissue are of primary importance. From present-day conceptions of the effect of ionizing radiation, it is theoretically possible that a radiocancer can originate from the smallest

possible dose. This theoretical assumption can not be verified by clinical results. Research that seeks to prove that a very small dose can lead to a radiocancer does not hold up to criticism since either the research is concerned with relatively large doses or the conclusions were drawn from statistics which are not satisfactory. (tr-auth)

90 THE EFFECT OF THE SPLEEN ON THE RADIATION DAMAGE AFTER WHOLE-BODY IRRADIATION. H.-J. Melching and O. Messerschmidt (Universität Freiburg i. B.). Med. Klin. (Munich), [55]: 1831-3 (1960). (In German)

A significant protective effect was obtained by splenectomy on mice 14 days before whole-body irradiation with LD_{82}. It was therefore assumed that the presence of an irradiated unprotected spleen is detrimental for the total organism and affects unfavorably the pattern of the radiation illness. This assumption was also verified by the fact that the survival rate is increased by splenectomy one hour after irradiation. Present results of extensive studies indicate that the negative effect of an irradiated spleen originates from tissue decomposition products. It must be questioned whether the whole-body irradiation of an organism represents a contraindication for splenectomy. Rather new methods for a prophylactic and therapeutic modification of radiation damage seem to be available on this basis. (tr-auth)

91 PLASMOCYTOMA FOLLOWING X-RAY DAMAGE. W. Pohl (Medizinischen Universitäts-Poliklinik, Jena, Ger.). Med. Klin. (Munich), [55]: 1839-42(1960). (In German)

Three cases of γ-plasmocytoma in anamnesis revealed a chronic x-ray exposure over the normal limits. After a casuistic representation (one x-ray assistant and two nurses) the present pathogenic conceptions of myeloma were briefly indicated. In addition to leukemia and polycythemia, plasmocytoma can be recognized as radiation damage and, if necessary, as an occupational disease. (tr-auth)

92 PRESENT QUESTIONS OF RADIOGENETICS IN THEIR SIGNIFICANCE FOR MAN. L. Loeffler. Med. Klin. (Munich), [55]: 1849-54(1960). (In German)

The basic factors in mutation occurrence are briefly sketched, and the supplementary factors in radioinduced mutation occurrence are reviewed. The effects of a doubled dose and research on mammals are considered. The significance of the research results with respect to man is discussed. (J.S.R.)

93 "QUESTION OF CANCER PRODUCTION BY IONIZING RADIATION." H.-J. Spechter (Universitäts-Frauenklinik Tübingen, Ger.). Med. Klin. (Munich), [56]: 318-20(1961). (In German)

The article by E. G. Mayer (Med. Klin., 41: 1824(1960)) in which he found slight evidence for the induction of cancers by radiation is critically answered. Five assumptions made in the original article are negated. In a conclusion Mayer answers each of the five criticisms. (J.S.R.)

94 RADIATION DAMAGE TO THE EMBRYO MATURING IN THE UTERUS (ANIMAL EXPERIMENTS). J. Trautmann, C. Kraft, B. Hoffmann, and D. Egner (Rontgeninstitut und der Strahlentherapeutischen Klinik am Stadtischen Krankenhaus Moabit, Berlin). Med. Klin. (Munich), 56: 861-8(May 1961). (In German)

A bibliographic study is made of radiation injury to maturing embryo in the uterus. Both cold- and warm-blooded animals are considered. (J.S.R.)

95 LATE DAMAGE TO THE SPINAL CORD AFTER X IRRADIATION. A. Frank, H. Girgenshohn, and R. Engel (Inneren Abteilung des Knappschafts-Krankenhauses Dortmund, Ger.). Med. Klin. (Munich), 57: 740-3(1962). (In German)

Late x-ray damage to the spinal cord after therapeutic irradiation of neighboring tumors occurs after one to two years, passes through varying, often uncharacteristic, neutrological symptom complexes, and then changes gradually into a total transverse paralysis. A clinical, pathological, and anatomical description is given of a myelomalacia of the lower dorsal and lumbar parts of the spinal cord, which developed two years after x-ray therapy of a deep-lying esophagus carcinoma. The late x-ray damage of the spinal blood vessel with secondary myelomalacia is definable in comparison with the other forms of vascular restricted spinal cord necroses. It can be confused with intra-spinal tumor metastases. (tr-auth)

96 INDUCTION OF SPECIFIC IMMUNOLOGICAL TOLERANCE OF HOMOGRAFTS IN ADULT MICE BY SUBLETHAL IRRADIATION AND INJECTION OF DONOR-TYPE SPLEEN CELLS IN HIGH DOSAGE. D. Michie and M. F. A. Woodruff (Univ. of Edinburgh). Proc. Roy. Soc., (London), B156: 281-90(July 31, 1962).

Adult A-strain mice in the weight-range 15 to 20 g were irradiated to 350 or 500 r, followed by the injection, divided between the intravenous and intraperitoneal routes, of suspensions of spleen cells obtained from CBA or (CBA × A) F_1 mice, donors and recipients being matched for sex. After the lapse of 18 to 25 days all mice, including control batches which had received irradiation but not spleen cells, were challenged with donor-type skin grafts. Mice irradiated to 500 r which received CBA spleen cells in doses from 500 to 1500 million developed severe graft-versus-host disease, fatal in most cases. Rejection of the grafts occurred in irradiated controls after periods ranging from 8 to 23 days. Mice receiving 500 r followed by (CBA × A) F_1 spleen cells showed prolonged survival of skin grafts, amounting to 90 days or more in animals which had received the highest dose of cells (12×10^8). Analysis of the phenomenon by means of Simonsen's discriminant spleen assay showed that approximately 85% of the immunologically competent spleen cells of the graft-bearing animals were replaced by cells of donor origin; the remainder, however, retained the power to react immunologically against third-party (C57BL) antigens. It was also possible to secure adoptive rejection of grafts by injection of 60 to 90 million A-strain lymph node cells pre-sensitized against CBA. It is concluded that the state of specific unresponsiveness induced in the adult A strain mice represented a specific central inhibition of the mechanism of immunological response and could thus be equated to immunological tolerance as classically defined. Prior splenectomy not only abolished the tolerance phenomenon, but actually reversed it, there being clear signs of an immunity resulting from the irradiation and injection procedure. This result is discussed in terms of the significance of antigen dose-level for the induction of tolerance. (auth)

97 MAINTENANCE OF GLOBULIN LEVELS IN X-IRRADIATED RABBITS AFTER IMMUNIZATION. Marvin B. Rittenberg and Eric L. Nelson (Univ. of California, Los Angeles). Science, 138: 519-20(Oct. 26, 1962).

Rabbits were injected with antigen 24 hours after x irradiation. Antibody titers were correlated with relative changes in gamma-beta globulin levels determined electrophoretically. Irradiated, immunized rabbits did not form detectable antibodies but had significantly greater globulin levels than non-immunized, irradiated controls. This relative difference occurred at the time nonirradiated, immunized rabbits were producing primary antibody. (auth)

98 ENZYMATIC AND HISTOCHEMICAL CHANGES AFTER APPLICATION OF IONIZING RADIATION. PART II. THE IMPORTANCE OF ENZYME STUDIES IN MALIGNANT BODY CAVITY EFFUSIONS AND TUMOR TISSUES DURING RADIOTHERAPY. Karl-Heinz Kaercher (Universität, Heidelberg). Strahlentherapie, 119: 23-37(Sept. 1962). (In German)

The simultaneous determination of enzyme activities in serum and in effusions in body cavities after application of radioactive isotopes showed that the rapid decay of tumor cells is followed by a considerable increase of activity in the effusion liquid. The increase does not appear if it is a cell free transudate. The increase of enzymes in the effusion has no influence on the values of the serum. The increase, which appears already one hour after the application of the isotopes permits the conclusion, that tumor cells have a good radiation sensitivity, because the enzymes are able to permeate the injured cell membrane. An increase of enzymes caused by an inflammation can be excluded in this case. Observation of the movement of enzyme activities in malignant effusions in body cavities may give information about the extent of the tumor decay after this kind of radiation therapy. (auth)

99 BEHAVIOR OF GLYCOGEN IN RADIUM-IRRADIATED CERVICAL CARCINOMA. August Verhagen (Städt. Frauenklinik Essen, Ger. and Evangelische Krankenhauses Plettenberg/Westf., Ger.). Strahlentherapie, 119: 38-46(Sept. 1962). (In German)

The behavior of carbohydrate metabolism of nonirradiated and irradiated carcinoma tissue is investigated histochemically and biochemically during the period of radiation therapy of 21 cervical carcinomas. (auth)

100 HEMATOLOGICAL STUDIES ON GUINEA PIG AFTER INCORPORATION OF LARGE DOSES OF RADIONUCLIDES. REPORT III. THE EFFECTS OF Zr^{95}, Ru^{106}, AND P^{32} ON THE PERIPHERAL BLOOD PICTURE. Ernst Spode (Instituts fur Medizin und Biologie der Deutschen Akademie der Wissenschaften, Berlin). Strahlentherapie, 119: 47-58(Sept. 1962). (In German)

The alterations of the composition of peripheral blood in guinea pigs after intraperitoneal injection of Zr^{95}, Ru^{106}, and P^{32} (2.5 μC/g body weight) are reported. Zr^{95} and Ru^{106} were slightly more effective than P^{32}. (auth)

101 THE CHEMICAL AND BIOLOGICAL PROTECTION AND TREATMENT OF MAMMALS. John F. Thomson and Harvey M. Patt (Argonne National Lab., Ill.). p.301-407 of "Medical and Biological Aspects of the Energies of Space." New York, Columbia University Press, 1961.

Developments during the past six years in the search for chemical and biological agents that afford protection against radiation injury are summarized. It is pointed out that hundreds of compounds have been tested. While some of these show protective effects in mice, results with higher animals have been discouraging. The most promising of the agents tested are too toxic to be of practical value. It is concluded that whole-body shielding is the only effective protective measure for man. (59 references.) (C.H.)

102 MOVING FIELD RADIATION THERAPY. Felix Wachsmann and Gunther Barth. Translated by Elisabeth Farber Lanzl. Adapted and expanded by Lawrence H. Lanzl and James W. J. Carpender. Chicago, University of Chicago Press, 1962. 282p. $10.95.

Moving field radiation therapy is a refined form of radiation therapy developed for the treatment of deep-seated tumors. The physical, technical, and clinical aspects of moving field therapy are discussed in detail. A subject index is included. (494 references.) (C.H.)

Radiation Sickness

Refer also to abstract 183.

103 DIAGNOSTICS, THERAPY, AND PROPHYLAXIS OF ACCIDENTS CAUSED BY RADIATION. P. Desaive (Université Liège) and J. Garsou. Arch. Belges Med. Sociale, Hygiene, Med. Travail Med. Legale, No. 10, 666-88(Dec. 1955). (In French)

After a definition of the primary physicochemical effects of radiation, the characteristics of the absorption of radiations by tissues, and the immediate causes of tissue radio-lesions, the radiological symptoms following either partial or whole-body exposure are analyzed. The particular symptoms of radiation sickness are then described. A survey is made of the therapeutic, preventive, and curative procedures used against local and general exposures to the principal types of radiation. (tr-auth)

104 INFLUENCE OF THE RADIATION PROTECTIVE AGENTS ON THE THERAPEUTICAL EFFECTS OF RADIATION FOR MALIGNANT TISSUES. Hideo Irie and Hidetosi Yosihara (Kyushu Univ., Japan). Chemotherapia, 3: 176-88(1961). (In English)

Results are reported from a series of experiments in rats on the effects of radiation protective agents on the response of tumors to therapeutic doses of x radiation. Animals having tumors in their legs were irradiated with the body shielded, with and without the administration of protective agents. The agents tested included the mercapto compounds, β-aminoethylisothiuronium Br(AET-Br), trans-dl-2-aminocyclohexanethiol HCl (trans ACT-HCl), and 2-mercaptoethylamine (MEA), and the restorative agents vitamin K and AC-17, a derivative of adrenochrome. Growth rates of the tumors were compared after 3 weeks. Data are tabulated. Results indicate that none of the agents interfere with the effects of x rays on the tumors. It is concluded that these agents may be used to eliminate the uncomfortable side effects during radiation therapy without reducing the effectiveness of radiation treatment on tumors. (C.H.)

105 LABORATORY AND CLINICAL STUDIES OF SOME QUINOL DIPHOSPHATES AND RELATED COMPOUNDS AS CHEMICAL RADIOSENSITIZERS AND THE DEVELOPMENT OF A RADIOACTIVE DRUG. D. H. Marrian, Barbara Marshall, and J. S. Mitchell (Univ. of Cambridge, Eng. and Addenbrooke's Hospital, Cambridge, Eng.). Chemotherapia, 3: 225-311(1961). (In English)

Results are summarized from a 15-year investigation of chemical radiosensitizers and the development of a radioactive drug to increase the efficiency and scope of radiotherapy of malignant diseases. Over 170 compounds were studied. The most effective was found to be tetrasodium 2-methyl-1:4-naphthaquinol diphosphate (Synkavite). Investigative procedures included effects in tissue cultures, effects on transplanted animal tumors, use in treatment of inoperable spontaneous tumors in domestic animals, studies of chemical toxicity in whole animals, tracer studies on the tissue distribution of potential radiosensitizers, electrode potential studies to observe the effects of various physical and chemical agents on oxygen tension, the use of plants, and other related procedures. Synkavite and a number of related compounds were found to show some degree of selective concentration in tumor cells. A tritiated compound of Synkavite with high specific activity was prepared and tested in 36 patients with advanced malignant disease. The compound produced useful palliation in at least 9 cases. Preliminary data are included on distribution of the com-

pound in tumors and normal tissues. Histological examination of autopsy specimens showed striking evidence of tumor retrogression in some tumors. Some evidence of regression was also noted in a case of chronic lymphatic leukemia. (203 references.) (C.H.)

106 HISTOLOGICAL CHANGES OF THE SKIN AFTER PERFORMING A GRAFT ON SCALDED, IRRADIATED RABBITS. L. B. Berlin and V. F. Zhupan (Korov Military Academy of Medicine, USSR). Dokl. Akad. Nauk SSSR, 146: 242-5(Sept. 1, 1962). (In Russian)

Severe radiation sickness was induced in rabbits by administering a single, x-ray dose of 600 r. A thermal burn 3 cm in diameter was inflicted on the inner surface of both ears in 80 rabbits by means of water heated to 83°C. The histological skin changes were followed in 20 of the rabbits, and skin transplants were performed on the other 60 rabbits at various times during the radiation sickness. The degenerative changes are described in detail. The skin transplants which were made during the latent period of the severe radiation sickness remained viable for 4 weeks. Various local conditions such as the depth of the thermal burn, the presence or absence of secondary infection in the wound, and the timing of the transplant after inflicting the wound had a substantial effect on the histological changes of the skin transplant. (TTT)

107 SUSCEPTIBILITY TO CARCINOGENESIS AT DIFFERENT AGES. R. Doll (London School Hygiene and Tropical Medicine). Gerontol. Clin., 4: 211-21(1962).

The influence of age on induction of cancer by various agents in man and animals is reviewed. It was concluded that although the incidence of cancer increases with age, in general, no clear-cut influence of age can be discerned. This is especially true of induction of cancer by ionizing radiation. Cancer occurs more frequently in the irradiated thyroid gland of children than of adults. On the other hand, the incidence of leukemia among atomic bomb survivors in Hiroshima shows no age dependence; although incidence of other types of cancer in the survivors shows an increase with aging. Incidence of cancer among patients irradiated for ankylosing spondylitis also shows an age-dependent increase. (H.H.D.)

108 PROTECTION OF PSEUDOMONAS SP. AGAINST GAMMA-RADIATION BY DIMETHYL SULPHOXIDE. B. A. Bridges (Wantage Research Lab., Berks, Eng.). Intern. J. Radiation Biol., 5: 101-4(Apr. 1962). (In English)

Dimethyl sulfoxide was found to afford protection to Pseudomonas species against the effects of x radiation under both anoxic and aerated conditions. Possible reaction mechanisms involved are discussed. (C.H.)

109 THE RADIOPROTECTIVE ACTION OF GUANYLTHIOUREA AND RELATED COMPOUNDS. Kathleen Stratton and Elizabeth M. Davis (Royal Free Hospital School of Medicine, London). Intern. J. Radiation Biol., 5: 105-21 (May 1962). (In English)

Compounds incorporating the thioureido and guanidino structures were tested for protective action against 900 r whole-body x radiation in mice. Guanylthiourea (toluene-p-sulfonate) gave 66% survival at 30 days. The more toxic oxidation product, 3,5-diamino-1,2,4-thiadiazole was four times more effective on a molar basis and gave 69% survival. Substituted derivatives and analogs were less protective. Autopsies and histological studies demonstrated little reduction of intestinal causes of death but considerable protection of the bone-marrow. It seems likely that these compounds have a similar mode of action to AET and cysteamine. (auth)

110 THE EFFICIENCY OF RADICAL PRODUCTION BY X-RAYS IN DRY PROTEINS AND NUCLEIC ACIDS. Adolf Mueller (Kernforschungszentrum, Karlsruhe, Ger.). Intern. J. Radiation Biol., 5: 199-200(May 1962). (In English)

Data are tabulated on the yields of radicals per 100 ev of absorbed energy for several proteins and nucleic acids exposed in the dry state to various doses of x radiation. Spectrographic recordings of paramagnetic absorption in the irradiated samples were analyzed and findings compared with previous results on amino acids. Results indicate that yields in proteins and nucleic acids are of the same orders as those in amino acids. Applications of the findings in efforts to elucidate the part played by radicals in primary mechanisms of radiation damage in biological systems are discussed briefly. (C.H.)

111 RADIOPROTECTIVE EFFECT OF COMBINATIONS OF AET OR CYSTEAMINE WITH DIMETHYL SULPHOXIDE. M. J. Ashwood-Smith (Medical Research Council, Didcot, Berks, Eng.). Intern. J. Radiation Biol., 5: 201-2(May 1962). (In English)

Combinations of 2-aminoethylisothiourea (AET) or cysteamine with dimethyl sulfoxide were shown to have a synergistic effect in the protection of mice against radiation injury when administered 30 min before x ray exposure. Dimethyl sulfoxide with AET was most effective. (C.H.)

112 CONTRIBUTIONS TO THE STUDY OF IMMEDIATE AND EARLY X-RAY REACTIONS WITH REGARD TO CHEMOPROTECTION. VI. RANDOM LIBERATION OF BIOGENIC AMINES AS A CAUSE OF EARLY IRRADIATION EFFECTS. T. S. Veninga and R. Brinkman (Univ. of Groningen, Netherlands). Intern. J. Radiation Biol., 5: 283-9(July 1962). (In English)

Doses of 1,000 r x radiation induced the liberation of serotonin and of adrenalins from suspended uterine horns of estrous rats pretreated with 5-OH tryptophan. After this pretreatment the uterine content of bound serotonin showed an increase, but the free form did not rise to concentrations effecting immediate contractions. Data are tabulated. It is concluded that the early reaction to irradiation is activated by the random liberation of active chemoprotective substances. (C.H.)

113 RESTORATIVE ACTION OF YEAST RIBONUCLEIC ACID AND ITS MIXED NUCLEOTIDES OF BONE-MARROW DEATH INDUCED IN RATS BY MYLERAN. J. Maisin, A. Dunjic, and P. Dumont (Université, Louvain, Belgium). Intern. J. Radiation Biol., 5: 291-300(July 1962). (In English)

Yeast ribonucleic acid (RNA) caused a definite decrease in the delayed mortality elicited by administration to rats of mid-lethal amounts of Myleran, and due to specific damage on myeloid tissue. The dose–reduction factor was found to be 1.14. Potency seemed logarithmically related to the dose and for a constant dose reached an optimum value when RNA was given within the 30 min of the ingestion of the myelotoxic. The beneficial effect was shared by the RNA alkaline hydrolysates and, to a lesser extent, by the mixture of the four purified ribonucleotides. Consequently, the integrity of the RNA molecular structure appeared by no means essential. In addition to its action on the lethality, it was shown that ribonucleic acid abolished the delayed loss of weight preceding the death of the control animals, which is the result of the Myleran myelotoxicity. The close similarity of the action of RNA against

effects of x rays and Myleran is stressed, and the hypothesis is put forward that RNA might act by promoting a regenerative mechanism rather than by repairing initial cellular damage. (auth)

114 INJECTION IMPLANTATION OF HEMATOPOIETIC TISSUES AS THERAPY AFTER LETHAL WHOLE-BODY IRRADIATION. J. Stein. Med. Klin. (Munich), [55]: 73-8(1960). (In German)

A bibliographic survey is made of studies carried out on the injection implantation of hematopoietic tissue for therapy after lethal whole-body irradiation. 147 references. (J.S.R.)

115 IRRADIATION OF MICE AND MEN. John F. Loutit. Chicago, The University of Chicago Press, 1962. 163p. $5.00.

Data are reviewed on the biological effects of radiation in mice and men. Topics discussed include radiation effects on intracellular targets and tissues, effects of radiation exposure on the life span, the induction of leukemia and cancer after radiation exposure, a comparison of effects from single and chronic exposure, the hazards from fission products in fall-out, the metabolism of calcium and strontium-90 in children and adults, and factors affecting the deposition of strontium-90 in bone. (C.H.)

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CHEMISTRY

General and Miscellaneous

Refer also to abstract 606.

116 (NP-12109) THEORY FOR STRONG ELECTROLYTES IN NOT TOO DILUTE SOLUTIONS. F. Cernuschi, M. Giambiagi, and M. Segre (Rio de Janeiro. Centro Brasileiro de Pesquisas Físicas). Mar. 12, 1962. 19p. (Notas de Física Vol. IX, No. 8, p.145-162).

Details of a theoretical model are presented in which the space around a positive ion in an electrolytic solution is described taking into account the interaction among first neighbors, and the possibility that a particular area is not occupied by ions. An expression is deduced for the Boltzmann constant which coincides with the reciprocal of Debye's characteristic, length, and retains a normalization factor. (J.R.D.)

117 SOME RADIOACTIVE SURFACE LABELLING METHODS. Bent Riber Petersen (Danish Isotope Centre, Copenhagen). Ingeniøren, 4: 99-102(Sept. 1960). (In English)

The investigation of material transport is often advantageously performed by radioactive tracers. Exploring by non-isotopic labeling is often necessary because of lack of conveniently activated isotopes in the material under investigation. Some methods for surface labeling are described. The labeling of sand with Cr^{51} in Curie quantities for investigation of littoral drift is described. The method is based on pre-treatment of the sand with sodium hydroxide and a following treatment with sodium (Cr^{51})-chromite. By this procedure a homogeneous and resistant surface labeling is obtained. Another and more general method for use in industrial investigations is the labeling of materials with Au^{198}. The principle of this method is the reduction of gold from a solution of gold-198 on the surface of the material to be labeled, this material having been pre-treated with stannous chloride. This method has been employed for the labeling of quicklime, cement, and other powdered materials, but a more general application for labeling seems possible. (auth)

118 CHEMISTRY OF THORIUM. PART III. SUBSTITUTION REACTIONS OF THORIUM(IV) CHLORIDE WITH SOME ORGANIC ACIDS. Sarju Prasad and Suresh Kumar (Banaras Hindu Univ., Varanasi, India). J. Indian Chem. Soc., 39: 444-6(July 1962). (In English)

Substitution reactions of $ThCl_4$ with several simple and substituted carboxylic acids were carried out by heating an excess of the acid with $ThCl_4$. The properties of the products obtained were studied and their structures discussed. (auth)

119 NAPHTHA HYDROFORMING BY IRRADIATION. Hillis O. Folkins (to Pure Oil Co.). U. S. Patent 3,055,814. Sept. 25, 1962.

A method is given for hydroforming naphthas boiling in the range of 250 to 400°F to higher octane number, higher aromatic content gasoline stock. The method comprises heating the hydrocarbons to their threshold thermal decomposition temperature (750 to 850°F) in admixture with hydrogen and a solid dehydrocyclization catalyst, and subjecting the mixture to high-energy radiation. This method results in less coke and gas being formed than in other methods using higher temperatures. (D.L.C.)

Analytical Procedures

120 (HW-26499(Del.)) X-RAY PHOTOMETRIC ASSAY OF PLUTONIUM IN METAL CASTINGS. M. C. Lambert (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 12, 1952. Contract W-31-109-eng-52. 32p.

Aspects of the x-ray-photometric method such as sample cell size, sample concentration, high-precision measurement techniques, preparation and use of U standards, and corrections for extraneous substances are discussed. Results obtained by the x-ray and chemical methods are compared. (J.R.D.)

121 (IDO-12023) DETERMINATION OF RADIUM 226 IN MILL EFFLUENTS. Earl R. Ebersole, Alan Harbertson, J. Kenneth Flygare, Jr., and Claude W. Sill (Idaho Operations Office. Health and Safety Div., AEC). Oct. 5, 1959. Revised July 1960. 26p.

Procedures are given for determination of Ra^{226} in effluents from mills processing uranium ores. Alpha-energy spectra graphs are given for precipitates separated from the mill effluent by various methods. Samples for determination of Ra^{226} were acidified with HNO_3 to make the sample 2% acid by volume. The radium is precipitated as sulfate with barium sulfate carrier and lead sulfate. These sulfates are dissolved in fuming perchloric acid, reprecipitated, and dissolved in EDTA-TEA solution. The pH of the solution is adjusted until barium and radium sulfates precipitate, leaving lead, radium daughters, and any thorium present in solution. The Ra^{226} activity can be determined by alpha counting at 3 hr and one week after precipitation. (M.C.G.)

122 (STL-B-37) ACTIVATION ANALYSIS. A LITERATURE SURVEY OF UNCLASSIFIED REPORTS. James R. Trew, comp. (Space Technology Labs., Inc., Los Angeles). Sept. 15, 1960. 25p. (STL/AB 60-5111-37)

A compilation of 44 abstracts on activation analysis is presented. (J.R.D.)

123 REMARKS ON THE USE OF THE "COPPER SPARK" METHOD FOR THE ANALYSIS OF RADIOACTIVE SOLUTIONS. J. Fiyałkowski and A. Zelle (Research Inst., Polish Academy of Sciences, Warsaw). Acta Chim. Acad. Sci. Hung., 30: 321-7(1962). (In German)

The spectrographic "copper spark" method, as a convenient process for the determination of traces of impurities in solutions, proved to be particularly suitable for the analysis of the radioactive solutions of I^{131}, P^{32}, and S^{35}. Under optimum conditions, the limit of detectability ranges down to 0.05 to 0.1 μg/ml in extremely dilute solutions. In the presence of amounts of accompanying metals over 50 to 100 μg/ml, the background intensity rises, leading to a decrease of detection limits. A similar effect is caused by a too strong acidity (particularly in the case of nitric acid). The effect of the following parameters is discussed: the pre-treatment of copper electrodes, the method of preparation of standard solutions, the technique of transferring and evaporating, respectively, of the solutions etc. Also the influence of the quartz vessel, which protects the electrodes, on the spectrum was investigated. All these parameters play an important role in quantitative determinations and may serve as error sources. To avoid errors, the best

method is to precisely carry out the prescriptions for the analysis of samples and standards, respectively. The choice of an adequate composition of standard solutions, together with the technique of transferring and evaporating the solutions are of particular importance. (auth)

124 STUDIES ON THE EVAPORATION OF ELEMENTS FROM REFRACTORY SPECTROGRAPHIC SAMPLES. L. Pszonicki (Research Inst., Polish Academy of Sciences, Warsaw). Acta Chim. Akad. Sci. Hung., 30: 351-8(1962). (In German)

On subjecting spectrographic samples to predistillation, it is possible to determine trace contaminations in samples whose basic substance shows an extremely rich spectrum, while in other cases the sensitivity of the procedure is markedly raised in this way. Also the effect of various additives (so-called spectrographic carriers) on the intensity of the spectral lines of contaminations was investigated, particularly in the case of U_3O_8. Silver chloride proved to be the most suitable carrier. The correlation between the intensity of spectral lines and the temperature of distillation and the quantity of carrier, respectively, was established, and the effect of carrier during distillation and excitation was studied. The effect of carrier proved not to be the same with all elements. During distillation, carriers play an appreciable role, particularly in the case of vanadium and molybdenum. Predistillation was carried out in a device constructed for this particular purpose, making possible a precise temperature control up to 2500°. The distilled contaminations are condensed directly on to the spectral electrode. (auth)

125 DETERMINATION OF RUBIDIUM AND CESIUM BY FLAME PHOTOMETRY. Zdeněk Řezáč and Josef Dvořák. Acta Chim. Akad. Sci. Hung., 30: 375-84(1962). (In German)

A quantitative method for the determination of rubidium and cesium by flame photometry suited for the analysis of various substances is presented. On previously destructing and preparing the sample to be analyzed, the intensity of the light emission of both elements is established by a spectrometer of the Hilger Uvispek type, equipped with an adapter for flame photometry. The evolved method makes possible the determination of quantities of rubidium from 5 to 200 ppm and those of cesium from 10 to 200 ppm. Also the effects of alien elements and the adequate flame temperatures are discussed. (auth)

126 SPECTROGRAPHIC TRACE ANALYSIS OF REACTOR SUBSTANCES. J. Czakow and J. Minczewski (Research Inst., Polish Academy of Sciences, Warsaw). Acta Chim. Akad. Sci. Hung., 30: 395-8(1962). (In German)

The spectrographic analysis of reactor substances actually pertain to trace analysis. Various techniques suitable for analyses of this type are discussed, as the "copper spark" method, the "sifter electrode" method, the pre-evaporation method, the dissolution methods applied after a previous enrichment, etc. Also the detection limits, reliability, and accuracy, further the techniques of the single procedures are given, based on experiences during five years. (auth)

127 QUANTITATIVE DETERMINATION OF LANTHANIDES BY MEAN DISPERSION SPECTROMETER. Janina Wysocka. Ann. Univ. Mariae Curie-Skladowska, Lublin-Polonia: Sect. AA, 15: 71-83(1960). (In Polish)

A quartz spectrometer was used for determining La, Sm, Eu, Ga, and yttrium in Ce-free oxides. Sm lines 3183.9, 3211.7, and 3218.6 Å were found in 0.5 to 6% Sm_2O_3; Eu lines 2813.9 and 2906.7 Å in 0.2 Eu_2O_3; Gd lines 3010.1, 3032.8, 2999.1 Å in 0.5 to 6% Gd_2O_3; and Y lines 3195.6, 3203.3, 3242.3 Å in 0.3 to 3% Y_2O_3. (R.V.J.)

128 PROBLEMS OF ANALYTICAL EVALUATION OF URANIUM NUCLEAR FUELS. Břetislav Buděšínský (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez and Prague). Chem. Listy, 56: 897-917 (1962). (In Czech.)

129 THE DETERMINATION OF SMALL QUANTITIES OF COBALT BY MULTIPLE ISOTOPIC DILUTION METHOD. Imrich Šebestian and Bohumil Žitňanský. Chem. Listy, 56: 948-51(1962). (In Czech.)

130 USE OF SHORT-LIVED RADIONUCLIDES IN ACTIVATION ANALYSIS. B. Chinaglia, L. Ciuffolotti, G. B. Fasolo, and R. Malvano (SORIN, Centro Ricerche Nucleari, Saluggia, [Milan]). Energia Nucl. (Milan), 9: 503-12(Sept. 1962). (In English)

The use of short-lived radionuclides is often convenient and sometimes necessary in activation analysis. For this kind of activation analysis, the techniques and apparatus used at the Reactor Centre of Saluggia are described. Some radionuclides having half lives in the range from about 10 seconds to about 10 minutes are considered: for these radionuclides the calculated sensitivities of detection and the characteristic gamma ray spectra are reported. Some examples of analytical determinations using short-lived radionuclides are also described. (auth)

131 SULPHODICHLOROHYDROXYDIMETHYL FUCHSON DICARBOXYLIC ACID AS A COLORIMETRIC REAGENT FOR THE MICRODETERMINATION OF BERYLLIUM. Surendra Nath Sinha and Arun K. Dey (Univ. of Allahabad, India). J. Indian Chem. Soc., 39: 469-74 (July 1962). (In English)

Beryllium forms a pink-colored chelate (λ_{max} 540 mμ) with Chrome Azurol S (sulfodichlorohydroxydimethyl fuchson dicarboxylic acid, color index 723). This was used in the colorimetric determination of beryllium on a micro scale and conditions for the measurements were worked out. Baer's law is adhered to with 0.01 to 0.33 ppm of beryllium in presence of a large excess of Chrome Azurol S. Measurements may be made over a wide range of temperature between pH 4.0 and 6.8. The sensitivity is 0.00045 γ/cm^2 (Sandell) and 0.0045 γ/cm^2 (practical). Copper, aluminum, iron, thorium, zirconium, borate, carbonate, oxalate, and citrate interfere in the determination. (auth)

132 ELECTROMETRIC CONTROL OF PHOTOGRAPHIC EMULSION WASHING PROCESS. František Bradna. Jaderna Energie, 8: 204-5(1962). (In Czech.)

An electrometric method of bromide ion excess determination in fused photographic emulsion is described. Measurements were carried out in simple glass apparatus. The measuring electrode is submerged in fused photographic emulsion, and the comparing electrode located in a vessel containing a standard AgBr sol. The comparative AgBr standard was prepared in saturated KNO_3 and thus the lowering of diffusion potential to a negligible value in the whole measuring range of p_{Br} 2.8–3.8 was reached. The concentration of bromide ions in the liquid phase is expressed as log[Br]. The use of the modified comparative standard enabled higher reproducibility and determination velocity without the use of a salt bridge. Membrane potential was defined and its reproducibility was verified under given conditions. The EMF of a given concentration cell was derived, and generalized results were gained after statistical evaluation of measurements on 100 samples of various gelatin types. (auth)

133 THE APPLICATION OF RADIOCHEMICAL METHODS IN THE FIELD OF SEMICONDUCTOR RE-

SEARCH. W. Gebauhr (Siemens-Schuckertwerke AG., Erlangen, Ger.). Kerntechnik, 4: 323-7(Aug. 1962). (In German)

Radiochemical methods are valuable auxiliary means for the examination of the important but small amounts of impurities in semiconductors. The effects of purification processes were checked using radioactive tracers. A few examples taken from the work on the purification of Sb and As and from zone melting will demonstrate this. The analysis of such materials by usual methods need concentration processes. The control of them best can be done with radioisotopes. One of the best methods in the field of trace analysis is activation analysis. On behalf of the absence of blank values extensive separation schemes are possible. For this, two examples are given. (auth)

134 AN EMANOMETER FOR DETERMINING THE RADON CONTENT OF NATURAL WATERS. Zoltán Dézsi. Magy. Tud. Akad. At. Kut. Int. (Debrecen) Kozlemen., 4: 51-5(May 1962). (In Hungarian)

135 QUANTITATIVE MEASUREMENT OF BETA RADIOACTIVE NOBLE GASES BY USING A SPHERICAL IONIZATION CHAMBER. Mikio Yamashita and Hironobu Watanabe (National Inst. of Radiological Sciences, [Tokyo]). Nippon Genshiryoku Gakkaishi, 4: 588-93(Sept. 1962). (In English)

An approach to the theoretical ionization efficiency of the spherical ionization chamber is described. Experimental discussions are presented. The ionization efficiency of a spherical chamber, derived on the assumption of the exponential law (as for the absorption of β particles in the ionizing gas), can be graphically estimated if the energy of β particles, the density of the ionizing gas, and the dimension of the chamber are given, together with knowledge of the backscattering factor and the energy distribution of backscattered radiation. The efficiency greatly depends upon the β absorption coefficient and upon the backscattering effect that occurs at the surface of the wall. The experimental discussions on the theoretical ionization efficiency are carried out by using point P^{32} and I^{131} sources and Ar^{41} gaseous sources. (auth)

136 FLUORINE BOMB CALORIMETRY. Ward N. Hubbard, Jack L. Settle, and Harold M. Feder (Argonne National Lab., Ill.). Pure and Appl. Chem., 2: Nos. 1-2, 39-44(1961).

Techniques which were developed for fluorine bomb calorimetry are described. Construction materials, safety measures, manipulation of samples, and calorimeter calibration are discussed. Tests carried out on 25 metals and metalloids and on 15 inorganic compounds indicated that reactions of 75% of these substances with fluorine could be studied calorimetrically. It is concluded that fluorine calorimetry can be carried out without undue hazard and is quite feasible. (D.L.C.)

137 SPECTROPHOTOMETRIC STUDY OF THE REACTION OF URANIUM(VI) AND IRON(III) WITH XYLENOL ORANGE. RAPID DETERMINATION OF TRACES OF IRON IN URANIUM. B. Buděšínský (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Z. Anal Chem., 188: 266-72(1962). (In German)

Optimal conditions were determined for the formation of complexes of UO_2^{2+} and Fe^{3+} with xylenol orange. The composition of the complexes was established and their stability constants calculated. On the basis of the results obtained, the general regularity of the mutual interfering reactions of UO_2^{2+} and Fe^{3+} complexes are derived, and the conditions for the determination of iron traces in uranium are given. The experimental results confirm the validity of the theoretical hypotheses. (tr-auth)

138 THE APPLICATION OF PARTITION CHROMATOGRAPHY TO THE SEPARATION OF RARE EARTH ELEMENTS. E. A. Chuveleva, P. P. Nazarov, and K. V. Chmutov (Inst. of Physical Chemistry, Academy of Sciences, USSR). Zh. Fiz. Khim., 36: 1022-7(May 1962). (In Russian)

It is shown that column partition chromatography may be used to separate rare earth elements. On the basis of the plate theory, the limiting stage of the process is diffusion in the sorbent-carrier particles. (auth)

139 COMPARATIVE EVALUATION OF AMERICAN AND GERMAN INDUSTRIAL ANALYZERS FOR TRACE DETERMINATIONS IN LIQUIDS AND GASES. H. Fuhrmann (Bran and Lubbe, Hamburg, Ger.). ISA Preprint No. 5.2.62. Pittsburgh, Instrument Society of America, 1962. (Prepublication Copy). 10p.

The various physical analysis methods and their industrial application for automatic measurement of traces of gas and liquids in the United States and Germany are compared. For detection of very minute traces in the lower ppm and ppb ranges, analyzers with chemical auxiliary reaction are described. Several examples are given in order to illustrate the operating method of these instruments. (auth)

140 RADIOMETRICHESKII EKSPRESS-ANALIZ DOBYTYKH RUD. (Radiometric Express-Ore Analysis). L. N. Posik, I. V. Koshelev, and V. P. Bovin. Moscow, Atomizdat, 1960. 79p.

A fast, γ-analysis, based on the ratio between the γ intensity and the quantity or weight concentration of active elements in an ore, is described. The analysis is especially suitable for sampling ore concentrates. The equipment is described, and the order of error is analyzed. (R.V.J.)

141 AUXILIARY METHODS OF ANALYSIS IN BETA AND GAMMA SCINTILLATION SPECTROMETRY. Gerald Anthony Bruno. Thesis, Lafayette, Ind., Purdue Univ., 1961. 103p.

A procedure is developed for determining the absolute efficiency of quenched solutions after the solutions are assayed by small-volume liquid-scintillation-counting techniques. The method, which is based on the correlation between counting efficiency and the ratio of count rates for different parts of the beta spectrum, is rapid, accurate, and dependable in routine counting operations. Applicability of the procedure to routine correction of urine and plasma sample activities is also demonstrated. Using cellosolve as a solubilizing additive, a system is developed capable of dissolving up to 5.84 ml of pure water (in a total volume of 20.0 ml at +5°C) and essentially equivalent amounts of urine and plasma. The solvent system and the counting procedure described can be used in biological investigations involving carbon-14 labeled materials, since the procedure provides a high figure of merit with convenience of sample analysis. A procedure is developed capable of spectrometrically resolving mixtures of gamma emitting isotopes having less than a twofold difference in energy. Different ratios of activities of iron-59 and cesium-137, assayed by large volume liquid scintillation counting techniques, are resolved with considerable speed and accuracy. (Dissertation Abstr., 22: No. 7, 1962.)

142 SEPARATION AND ANALYSIS OF BASTNAESITE RARE EARTHS. David R. Maneval. Thesis, University Park, Penna., Pennsylvania State Univ., 1961. 103p.

A method was developed by which solid bastnaesite rare

earth oxide concentrates or carbonate concentrates were successively reacted by digestion with a kerosene solution of heptadecyl phosphoric acid (Dowsol-17) or dodecyl phosphoric acid (Dowsol-12), followed by leaching with water, alkali solution, and nitric acid at 100°C. Following Dowsol treatment, solubility trends for pure cerium and praseodymium oxides and carbonates, and lanthanum and neodymium carbonates, were determined using these solvents. Mixtures of pure oxides and pure carbonates approximating the composition of the bastnaesite concentrates were also treated in the same manner. The solutes from each step and the insoluble residues were analyzed. A quantitative x-ray fluorescence spectrographic technique was developed by which lanthanum, cerium, praseodymium, and neodymium could be determined as major components. The method involved the dissolution of rare earth material in fused borax followed by the x-ray analysis of the borax glass discs. The dilution thus obtained satisfactorily minimized errors resulting from absorption and enhancement effects and heterogeneity variations. The analyses of four samples of widely varying composition showed a mean error of less than 5%. With these four elements, interference from other rare earth oxides is generally insignificant. A semi-quantitative technique for the same elements based on the interpretation of qualitative x-ray spectrograms was developed. It was concluded that solid bastnaesite rare earth material reacted with a kerosene solution of alkylphosphoric acids to yield products soluble to varying degrees in kerosene, water, alkali, and acid. Rare earth carbonates, with some exceptions, were more reactive than the oxides. Rare earth carbonates were more reactive with Dowsol-12, whereas the rare earth oxides were more reactive with Dowsol-17. There was evidence that the rare earths in the natural materials were in a true solid solution or in mixed crystals, rather than existing as discrete compounds. Synthetic mixtures of the pure oxides and carbonates of the same elemental composition as the natural materials did not respond the same as these natural products to the reaction and extraction treatment. The cerium in bastnaesite ore was found to be, at least in part, in the cerous rather than the ceric state as evidenced by its acid solubility. Cerium and praseodymium were found to be very similar in many of their reactions and solubilities. No other combination studied was found to be so closely related. This similarity of reactivity may be the result of the formation of a tetravalent rare earth complex in the case of both elements. Lanthanum and neodymium maintained their tervalent status. A separation scheme with industrial potentialities may be feasible based on the reaction of Dowsol-12 and the bastnaesite carbonates. The digestion scheme was outlined. (Dissertation Abstr., 22: No. 7, 1962.)

143 FLUORESZENZ POLYCYKLISCHER, AROMATISCHER KOHLENWASSERSTOFFE IN FESTEN LÖSUNGEN BEI 79°K. (Fluorescence of Polycyclic Aromatic Hydrocarbons in Solid Solutions at 79°K). Martin Koehler. Thesis, Mainz, Johannes Gutenberg Universitat, 1962. 1p.

A cooling apparatus was developed for taking fluorescent spectra at low temperatures (79°K, temperature of liquid air). The apparatus exhibits a sufficient cooling effect and permits a rapid sample exchange. Together with a 500 w mercury high-pressure tube and a recording adaptor, it forms a sensitive measurement apparatus with which 4×10^{-11} g 3,4-benzopyrene could be detected. Solutions of the polycyclic aromatic hydrocarbons anthracene, 3,4-benzopyrene 1.2, 5.6-dibenzanthracene, and 20-methylcholanthrene in n-heptane were investigated at 79°K. The fluorescent spectra of the microcrystalline lines of solid solutions show a resolution of the broad bands present at normal temperature into intense fine lines which correspond in their half-value width to the spectra of a mercury high-pressure tube. The differentiated variation of the individual spectra permit detection of several compounds of similar structure. This is of special significance for the analysis of materials which contain a series of cancer-producing polynuclear aromatic compounds. As a model for the analysis of a natural product, mixtures of anthracene with the cancer-producing compounds 3,4-benzopyrene, 1.2, 5.6-dibenzanthracene and 20 methylcholanthrene were investigated. The detection of individual components in the spectrum was possible at a wake ratio of 10:0, 1:100:10. After chromatographic separation of the mixtures on acetylated paper, the detection of the individual components is possible from the fluorescent spectra even at extreme mixture ratios. The method was applied to the analysis of air dust. In a sample from 91.2 m^3 air the concentration of 3,4-benzopyrene was determined with C = 0.05 to 0.1 $\gamma/1000\ m^3$. (tr-auth)

144 DIE RÖNTGENFLUORESZENZANALYTISCHE BESTIMMUNG GERINGER SCHWERMETALLKONZENTRATIONEN IN DEN OXYDEN DER 4. NEBENGRUPPE. (X-ray Fluorescence Determination of Low Heavy Metal Concentrations in the Oxides of the 4th Side Group). Dietrich Ankner. Thesis, Mainz, Johannes Gutenberg Universität, 1961. 2p.

A study was made to determine to what extent low concentrations of Sb, Zn, Ni, and Fe could be determined by x-ray fluorescence in the dioxides of Ti, Zr, and Th. A study was also made to determine the detection limit for U in ThO_2. For evaluation of the results the most extensive error analysis possible was carried out. The statistics of the errors to be expected were calculated for the two best known evaluation methods. It is shown that the application of the net pulse contribution is more suitable than the ratio of the net pulse contribution background. The errors caused by the apparatus were determined experimentally and estimated. The selection of the shielding and excitation conditions were discussed for determining the optimum conditions for the measurement of the fluorescent radiation, and the channel calibration for the pulse type analysis was established. The results were plotted graphically as a function of concentration, and they showed that in all cases of low concentration a linear dependence was obtained between net pulse contribution and concentration. The calibration equations were given. The limits of detection of the elements cited in the matrices studied were determined with consideration of the total error, which was calculated from the statistical and the apparatus errors. At a counting time of five minutes for background and line maximum, the detection limits in TiO_2 are 0.003% for Sb, 0.001% for Zn, 0.001% for Ni, and 0.004% for Fe; in ZrO_2 they are 0.011% for Sb, 0.003% for Zn, 0.003% for Ni, and 0.006% for Fe; in ThO_2 they are 0.019% for Sb, 0.006% for Zn, 0.005% for Ni, and 0.015% for Fe. The increase of the detection limits in ZrO_2 and ThO_2 can be traced to the increasing absorption of the characteristic radiation of the elements in these matrices. A detection limit of 0.02% was found for U in ThO_2. The values given can be reduced by increasing the counting time. It should be observed however, that the counting time is limited by the apparatus errors. In the apparatus errors observed, a significant improvement of the detectability was not possible. A study was made to carry out a theoretical calculation of the calibration equation for the x-ray fluorescence analysis of an element in various matrices when the calibration equation for one matrix is known. (tr-auth)

Inorganic and Physical Chemistry

Refer also to abstracts 12 and 13.

145 (BM-RI-6060) THERMAL DECOMPOSITION OF FIVE SALTS OF PRASEODYMIUM, NEODYMIUM, AND SAMARIUM. Roy L. Wilfong, Louis P. Domingues, and LeRoy R. Furlong (Bureau of Mines, College Park Metallurgy Research Center, Md.). Jan. 1962. 18p.

The thermal decomposition of the ammonium sulfate, carbonate, nitrate, oxalate, and sulfate salts of praseodymium, neodymium, and samarium was investigated thermogravimetrically in the temperature range 25 to 1500°C. Each salt was decomposed at a heating rate of 2.5°C per minute. The pyrolytic sequences were identified and the temperatures of formation of intermediates, the minimum oxide formation temperatures, and values for loss on ignition were determined. The nonstoichiometric ranges between Pr_6O_{11} and Pr_2O_3 and the extent of these ranges were determined for oxides derived from the carbonate, nitrate, and oxalate salts of praseodymium. The alum and sulfate salts of praseodymium produced the sesquioxide without forming the intermediate nonstoichiometric oxides. The temperature limits of formation and regions of stability for the alums and sulfates were better defined than were those for the carbonates, nitrates, and oxalates. The minimum oxide formation temperature increased in the order of samarium, neodymium, and praseodymium irrespective of the anion. (auth)

146 (IA-720) PREPARATION AND PROPERTIES OF SOME SYNTHETIC INORGANIC ANION EXCHANGERS. Progress Report. I. Schoenfeld (Israel. Atomic Energy Commission, Tel Aviv). Apr. 1962. 45p.

The preparation and properties of various inorganic anion exchangers are described. The distribution of trace iodide, chromate, and chlorozincate anions between hydrous zirconium oxide and aqueous solutions was studied as a function of the precipitation conditions, acid treatment, and drying temperatures. Exchangers consisting of insoluble hydroxides in which part of an n-valent metal was substituted by an n + 1 or n + 2 valent one (materials of the last type were not previously considered as anion exchangers) and zirconium ferrocyanide were also investigated by similar methods. (auth)

147 (IS-557) ACID-BASE REACTIONS AND KINETICS OF THE HALATES IN FUSED NITRATES. James Max Schlegel and F. R. Duke (Ames. Lab., Ames, Iowa). Nov. 1962. Contract [W-7405-eng-82]. 69p.

The reactions of the halates, bromate, chlorate, and iodate, with dichromate in fused alkali nitrates were shown to involve a fast equilibrium followed by a slow rate-determining step to give O_2 and halogen gases as final products. Ba ion was added to precipitate chromate ion and displace the equilibrium. The rate step for the bromate reaction involves an unimolecular decomposition of bromyl ion, BrO_2^+. The rate step for the other halates involves the oxidation of a halide ion by the intermediate ion, XO_2^+. The equilibrium step is the same for all three halates. The relative acidity of the intermediate ions, XO_2^+, in the presence of dichromate are $BrO_2^+ < IO_2^+ < ClO_2^+ \approx NO_2^+$. Previous attempts to separate the equilibrium constant and the rate constant directly for the dichromate-nitrate reaction were unsuccessful. However, in these attempts Pb ion was used to precipitate the chromate ion, and Pb ion reduces the activity of dichromate and bromide by forming complexes. Replacing the Pb ion with Ba ion, these constants were separated, thus making it possible to compare the nitryl ion with the other intermediate ions. The subsequent decomposition following the fast equilibrium step has not been completely characterized for the chlorate reaction. (auth)

148 (JEN-95-DMe/I-8) CONTRIBUCIÓN AL ESTUDIO CINÉTICO DE LA REACCIÓN METATÉCTICA $U + U_3Si_2 \rightarrow U_3Si$. (A Contribution to the Kinetic Study of the Metatectic Reaction $U + U_3Si_2 \rightarrow U_3Si$). J. Arroyo Ruiperez and J. A. Esteban Hernandez (Spain. Junta de Energía Nuclear, Madrid). 1962. 33p.

An experimental study was made to decide upon the advantages and drawbacks of the different methods and reagents employed in the metallography of U–Si alloys. It has been observed that all samples thermally treated to the epsilon-phase undergo a coalescence of the U_3Si_2 particles. The coalescence decreases the surface available for reaction and consequently the reaction rate. The growth of the U_3Si_2 phase particles was determined as a function of time and temperature. To obtain samples with nuclei sufficiently isolated so that the U_3Si rings will not interfere their respective growth, the conditions that regulate coalescence, Si content and thermal treatment, were determined. Data relative to the growth of the U_3Si phase-rings were obtained. Curves relating growth, time, and temperature are presented. The parameters that define the diffusion regulated reaction can be deduced from these curves. (auth)

149 (LADC-5487) THE THERMODYNAMIC PROPERTIES OF THE URANIUM AND PLUTONIUM CARBIDES. A Report to the Panel on the Assessment of Thermodynamic Data of Uranium and Plutonium Carbides, Vienna, Austria, October 8-12, 1962. Charles E. Holley, Jr. (Los Alamos Scientific Lab., N. Mex.). Contract [W-7405-eng-36]. 19p.

The thermodynamic properties of plutonium and uranium carbides are investigated at temperatures from 298 to 2500°K. The thermodynamic properties considered are heat of combustion, heat of formation, free energy of formation, entropy of formation, absolute entropy, and heat content, with special emphasis on heat of combustion and errors in its measurement. The carbides are studied with regard to the different carbon forms and content. (N.W.R.)

150 (NP-12085) MEASUREMENT OF NUCLEAR QUADRUPOLE INTERACTION IN IRON COMPLEXES USING THE MOSSBAUER EFFECT. Neyla L. Costa, J. Danon, and R. Moreira Xavier (Rio de Janeiro. Centro Brasileiro de Pesquisas Fisicas). 1962. 7p. (Notas de Fisica Vol.IX, No. 5(p.75-80)).

Nuclear quadrupole splitting and isomer shifts were measured for iron complexes at room temperature. The quadrupole coupling measurements were made by measuring the Mossbauer effect with iron in different electronic surroundings. The 14 different complexes in the bivalent and trivalent state of the spin-free and spin-paired type were investigated as absorbers. The complexes include potassium ferrocyanide, potassium ferricyanide, sodium nitroprusside, other substituted cyanides, ferrous oxalate, and halide substituted complexes. The data on the isomer shift indicate that the electron density at the nucleus is smallest in spin-free Fe^{2+}, and progressively increases in spin-free Fe^{3+}, spin-paired Fe^{2+}, and spin-paired Fe^{3+}. This shows that the electron of the ligands must be closer to the iron nucleus in the spin-paired case in order to increase the separation between d_ϵ and the d_γ orbitals. (N.W.R.)

151 (TID-16987) THERMODYNAMIC PROPERTIES OF ACTINIDE CARBIDES WITH SPECIAL REFERENCE

TO THE ENTROPIES OF URANIUM MONO- AND DICARBIDE. Edgar F. Westrum, Jr. (Michigan Univ., Ann Arbor. Dept. of Chemistry). [1962]. Contract AT(11-1)-1149. 17p.

The thermodynamic properties of uranium mono- and dicarbide were investigated. Special emphasis is given to the entropies and heat capacities from 10 to 350°K. The heat capacity of the dicarbide is greater than that of the monocarbide. (N.W.R.)

152 (AEC-tr-5385) HEAT OF HYDRATION AND VAPOR PRESSURE OF THORIUM SULFATE HYDRATES. I. Koppel. Translated for Oak Ridge National Lab., Tenn., from Z. anor. Chem., 67: 293-301(1910). 13p.

The possibility for an indirect determination of the vapor pressures of thorium sulfate hydrates from its relation to the heat tone which accompanies the conversion of thorium sulfate octahydrate into the tetrahydrate. The heats of solution of thorium sulfate were determined in a glass calorimeter. The vapor pressure of the octahydrates was calculated from the composition of the solutions in equilibrium with it according to the Raoult equation. The heat of hydration was calculated to be 14,424 cal, and the mean measured value was 13,523 cal. The vapor pressure values of the octahydrate derived from the solubility determinations for 30°C were confirmed by the direct determination of the heat of hydration. (M.C.G.)

153 (AEC-tr-5396) SPECTRUM, ZEEMAN EFFECT AND ELECTRON LEVELS OF TRIVALENT ERBIUM IN CRYSTALLINE SALTS. I. ERBIUM ETHYLSULPHATE $Er(C_2H_5SO_4)_3 \cdot 9H_2O$. K. H. Hellwege, S. Hufner, and H. G. Kahle. Translated for Ames Lab., Ames, Iowa from Z. Physik, 160: 149-61(1960). 18p.

The visible absorption spectra of trivalent erbium ions in hexagonal erbium- and (erbium-yttrium)-ethylsulfates and their Zeeman effect in the outer magnetic field are absorbed at low temperatures and explained by assuming a crystalline field of the symmetry D_{3h}. The J-values and the topographic g-factors are determined and discussed. The values of the crystalline quantum number $\bar{\mu}$ for the splitting components of the electron levels and some crystalline field matrix elements are indicated. (auth)

154 THE CRYSTAL STRUCTURE OF CALCIUM HYDRIDE. J. Bergsma and B. O. Loopstra (Reactor Centrum Nederland, Petten). Acta Cryst., 15: 92-3(Jan. 1962). (In English). (RCN-7)

Neutron-diffraction patterns of CaH_2 and CaD_2 were measured to obtain more information on the positions of the hydrogen atoms. The results are in disagreement with those of Zintl and Harder, and calculations on the basis of a CaH_2 model were found to agree with the experimental data while those of Zintl and Harder's model did not. The structure of CaH_2 is discussed. (D.L.C.)

155 DETERMINATION OF IONIC WEIGHT OF COMPLEX COMPOUNDS BY DIALYSIS. [PART] II. Barbara Frank. Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia: Sect. AA, 15: 85-103(1960). (In Polish)

Dialysis and ionic weight coefficients of Ce(IV) carbonate complexes were determined. The product $\lambda\sqrt{M}$, calculated for cerium, is quite similar to the mean magnitude $\lambda\sqrt{M}$ = 3.58 obtained previously for Th, Zr, and UO_2 carbonates with ionic weights exceeding the weights of simple complex groups. Electrophoresis and other physico-chemical analyses showed that tetravalent metals and uranyl ions are found in anionic form. Spectrophotometric measurements revealed that regardless of the intensity of CO_3^{2-} saturation, one UO_2^{2+} ion binds three CO_3^{2-} ions. Amperometric titration of thallium carbonates results in insoluble thallium ammonium salts. (R.V.J.)

156 THE DETERMINATION OF THE HEAT OF VAPORIZATION OF BORON OXIDE BY A MASS-SPECTROMETRIC METHOD. O. T. Nikitin and P. A. Akishin (Moscow Univ.). Doklady Akad. Nauk SSSR., 145: 1294-6(Aug. 21, 1962). (In Russian)

In determining the heat of vaporization (ΔH_T) of B_2O_3, special precautions must be taken to avoid reaction of B_2O_3 with traces of water vapor. The B_2O_3 charge was outgassed in vacuum for 1 to 3 hours at a temperature of 1200°C. The evaporation of the boron oxide was carried out from a molybdenum effusion chamber. The ion source of a mass spectrometer was placed in the effusion chamber, and the B_2O_3 was subjected to additional dehydration at 1100°C directly in the mass spectrometer. The ion current of $B_2O_3^+$ ion was determined as a function of the temperature of the effusion chamber in order to obtain the heat of vaporization. The vapor pressure of B_2O_3 is given by the following equation: $\lg p_{atm} = (7.44 \pm 0.16) - (84{,}500/4.576\ T)$. The heat of vaporization ΔH_T (B_2O_3) = 84.5 ± 0.5 kcal/mol in the interval of temperatures from 1315 to 1529°K. (TTT)

157 ELECTRON PARAMAGNETIC RESONANCE IN Nb^{4+}. V. N. Fedotov, N. S. Garif'yanov, and B. M. Kozyrev (Kazan Affiliate of the Academy of Sciences, USSR). Doklady Akad. Nauk SSSR, 145: 1318-20(Aug. 21, 1962). (In Russian)

$NbCl_4$ was formed by reducing an ethanol solution of $NbCl_5$ with Zn and HCl according to the following reaction: $NbCl_5 + NbCl_3 \rightleftharpoons NbCl_4$. The reaction is slow, and the electron paramagnetic resonance (EPR) effect due to $NbCl_4$ is greater after a day than it is immediately after reduction. The EPR measurements were carried out at a frequency of 9320 megacycles per sec at 77°K. A complex spectrum consisting of 16 lines of the superfine structure was observed in an ethanol glass containing 0.1 mol/l $NbCl_4$. The lines are due to the interaction of an unpaired $4d^1$ electron with the Nb^{93} nucleus. The spectrum can be described by the spin Hamiltonian: $H = g_{||}\beta H_z S_z + g_{\perp}\beta (H_x S_x + H_y S_y) + A I_z S_z + B (I_x S_x + I_y S_y)$ with values of $S = 1/2$, $I = 9/2$, $g_{||} = 1.82$, $g_{\perp} = 1.80$, A = 270 ± 10 oe and B = 146 ± 10 oe. (TTT)

158 A STUDY OF THE INFRARED SPECTRA OF URANYL COMPLEXES WITH THE SCHIFF BASES, AND THE DETERMINATION OF THE LENGTH OF THE U=O BOND. V. V. Zelentsov. Dokl. Akad. Nauk SSSR, 146: 97-9(Sept. 1, 1962). (In Russian)

The symmetrical vibration bonds ν_1 and the unsymmetrical valence bonds ν_3 of the U=O bond in uranyl compounds lie within the limits of 830 to 880 cm^{-1}, and 900 to 940 cm^{-1} respectively. The ν_3 bond and the force constant of the U=O bond is sensitive to changes in the bond strength of the uranyl group with various ligands. The infrared spectra of the tetrahydrate, the semihydrate, the ethanolate, the butanolate, and methanolate of uranyl salicyl-o-oxyanilate were investigated along with various other azomethine uranyl derivatives. An intense adsorption bond in the region of 900 to 930 cm^{-1} was attributed to the asymmetric valence oscillations ν_3 of the uranyl group. A less intensive bond ν_1 was found in the region of 872 to 886 cm^{-1}. The force constant of the U=O bond was calculated from the formula: $K_{U=O} = 0.029447\ m_0[\nu_1^2 + (m_u/m_0 + m_u)\nu_3^2]$. Here ν_1 and ν_3 are the wave numbers (cm^{-1}), and m_0 and m_u are the masses of oxygen and uranium in atomic units. The length of the U=O bond was calculated from the formula: $R_{U=O} = 1.08\ K_{U=O}^{-0.33} + 1.17$. Here $R_{U=O}$ is the U=O bond length in Å, and $K_{U=O}$ is the force constant in mdyn/Å. The valency of

the bond as calculated from the bond length and the force constant turned out to be 2.2 to 2.3. (TTT)

159 A STUDY OF THE STABILITY OF ZIRCONIUM AND HAFNIUM TETRAHALIDES ON HITTING A HOT SURFACE IN VACUUM. V. I. Tsirel'nikov, L. N. Komissarova, and Vikt. I. Spitsyn (Moscow Univ.). Dokl. Akad. Nauk SSSR, 146: 122-4(Sept. 1, 1962). (In Russian)

The decomposition coefficients of the chlorides, bromides, and iodides of Zr and Hf were determined as a function of the temperature of a hot surface. The tetrahalides were carefully purified in an inert atmosphere of argon. The halide compound in a quartz ampoule was heated by a removable heater. The vapors passed through a capillary opening and struck a tungsten foil 0.5 mm thick and 12 to 15 mm wide. The Mo foil was heated electrically to control the surface temperature which was measured by an optical pyrometer. The tetrahalide decomposed according to the following reaction: $Me(Hal)_4 \rightarrow Me + 2(Hal)_2$. The lower halides dissociated completely to metal and free halides, since the temperature was >600°C. The Mo backing was dissolved in nitric acid, and the unsupported metal deposit of Zr or Hf was weighed. The decomposition coefficient was calculated as the ratio of the weight of metal deposited to the weight of metal evaporated. ZrI_4 decomposed completely (100%) at 1500°C, while only 96% of the HfI_4 was decomposed at this temperature. The $ZrBr_4$ and $HfBr_4$ were decomposed by 68 and 61% respectively. The $ZrCl_4$ and $HfCl_4$ were stable at 1500°C (5% of the $ZrCl_4$ was decomposed at 1500°C). In all cases, the hafnium halide was more stable than the zirconium halide, especially in the case of the iodides. The decomposition was directly proportional to the temperature of the molybdenum target. (TTT)

160 THE IMPEDANCE OF THE DOUBLE ELECTRICAL LAYER IN A FUSED SALT. A. V. Gorodyskii, Yu. K. Delimarskii, and E. V. Panov (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Dokl. Akad. Nauk SSSR, 146: 129-30(Sept. 1, 1962). (In Russian)

A current expended in charging a double electrical layer passes through a capacitance resistance X and an electrolyte resistance ρ. In general, the values of X, R, and ρ cannot be calculated from impedance measurements. However, the resistance ρ can be determined by varying the distance between the electrodes by a factor n. The impedance measurements gave values of x and $A = r + \rho$. For the two distances l_1 and l_2 between the electrodes, the following relations were obtained: $l_1/l_2 = \rho_1/\rho_2 = n$, $A_1 = r + \rho_2 n$, and $A_2 = r + \rho_2$. Then, $r = (A_1 - nA_2)/(1-n)$. Also, $R = (x^2 + r^2)/r$ and $X = (x^2 + r^2)/x$. Here X is the resistance of the actual capacity of the double electrical layer. The distance between two platinum wire electrodes was varied from 70 to 220 mm, and impedance measurements were carried out on a KNO_3 melt at 420°C and on a molten KNO_3-$NaNO_3$ eutectic at 280°C. The results of the measurements show that x and r are independent of the distance between the electrodes, and that the actual capacity of the double electrical layer can be determined by this method. (TTT)

161 FACTORS CONTROLLING THE RATE OF ELECTRON TRANSFER. I. THE EFFECT OF HALOGEN SUBSTITUTION IN ORGANIC MEDIATORS. R. T. M. Fraser (Univ. of Ottawa). J. Am. Chem. Soc., 84: 3436-41 (Sept. 20, 1962).

A kinetic study was made of the reduction by Cr^{2+}, V^{2+}, or Eu^{2+} of complex ions of the type $(NH_3)_5Co(III)L$, where L is a halogen derivative of acetic, benzoic, or fumaric acid. With the acetato and benzoato complexes, the rate of chromous ion reduction decreases as the size of the substituent increases. Changes in opposite directions in $\Delta S^{\ddagger}$ in chromous and vanadous reactions are interpreted in terms of substitution labilities of the reductants. Substitution of $-CO_2H$ in the 2-position of the ligand catalyzes reduction by V^{2+} and Eu^{2+}; $-OH$ in the 2-position catalyzes reduction by Cr^{2+}. The role of halogen substitution in fumaric acid is more complex, but can be related both to the size of the halogen and its electromeric effect. All three reductants react by inner-sphere (bridged) activated complexes. (auth)

162 XENON TETRAFLUORIDE. Howard H. Claassen, Henry Selig, and John G. Malm (Argonne National Lab., Ill.). J. Am. Chem. Soc., 84: 3593(Sept. 20, 1962).

Xe and F_2 were found to react readily under certain conditions to form XeF_4, a stable solid which does not melt up to 100°C. The method of preparation comprises heating a mixture of 1 part Xe and 5 parts F_2 to 400°C for 1 hr and then rapidly cooling the mixture to room temperature. Some of the physical and chemical properties of XeF_4 are described. (D.L.C.)

163 ON THE KINETIC THEORY OF SIMPLE DENSE FLUIDS. XI. EXPERIMENTAL AND THEORETICAL STUDIES OF POSITIVE ION MOBILITY IN LIQUID Ar, Kr, AND Xe. H. Ted Davis, Stuart A. Rice, and Lothar Meyer (Univ. of Chicago). J. Chem. Phys., 37: 947-56(Sept. 1, 1962).

Measurements of the mobility of positive ions in liquid Ar, Kr, and Xe at various temperatures and pressures and an extension of the theory of Rice and Allnatt to the description of ionic motion are reported. It is found that (a) The magnitude, the pressure dependence, and the temperature dependence of the positive ion mobility in liquid Ar, Kr, and Xe can be quantitatively accounted for by an extension of the theory of Rice and Allnatt [S. A. Rice and A. R. Allnatt, J. Chem. Phys. 34: 2144 (1961)]. As in previous studies of self-diffusion in these same liquids [J. Naghizadeh and S. A. Rice, J. Chem. Phys. 36: 2709 (1962)], it is found that negative contributions to the momentum autocorrelation function are of dominant importance. (b) Modification of the simple Nernst-Einstein relationship between the charge mobility and the self-diffusion constant of the parent atom by inclusion of the effects of polarization leads to quantitative agreement between theory and experiment. (c) The effect of the long-range Coulomb potential is to increase the local density about the ion and thereby to increase the frictional forces arising from the short range interaction potential. The rate of dissipation of energy directly by the long-range Coulomb potential is small compared to the rate of energy dissipation by the short-range potential. (d) The agreement between experiment and theory is very satisfactory if the positive ion is Ar_2^+, Kr_2^+, or Xe_2^+ and it is suggested that this is the ionic species present. Agreement is much poorer if a different ionic species (say Ar^+) is postulated. (e) If the ions are regarded as probes to alter and study the liquid structure, it can be deduced that the current theory of liquids seriously miscalculates the change in the equilibrium pair correlation as a function of temperature and pressure. It is believed that the error arises from either a premature truncation of a slowly convergent series used in the solution to an integral equation or, at worst, that the assumed series expansion is invalid [T. L. Hill, Statistical Mechanics (McGraw-Hill Book Company, Inc., New York, 1956)]. (auth)

164 THE PREPARATION OF SINGLE CRYSTALS OF SOME RARE EARTH TELLURIDES. P. Bro (Avco Corp., Wilmington, Mass.). J. Electrochem. Soc., 109: 1110(Nov. 1962).

The growth of single crystals of rare-earth sesqui- and di-tellurides by the vapor transport method is reported.

The crude tellurides were heated with iodine in evacuated quartz tubes, and single crystals were formed on the cool sides of the tubes. Some of the properties of the crystals are described briefly. (D.L.C.)

165 KINETIC STUDIES ON SLOW COAGULATION OF CeO_2 SOL. S. Bandyopadhyay (Univ. Colleges of Science and Tech., Calcutta). J. Indian Chem. Soc., 39: 453-7(July 1962). (In English)

A modified form of Smoluchowski's equation on kinetics of slow coagulation, proposed by Ghosh, was tested with CeO_2 sol. An indirect method of investigation developed by Mukherjee was adopted. The autocatalytic nature in the coagulation-velocity curve was found to be absent in well-dialyzed CeO_2 sol even after the addition of co-ions. (auth)

166 ON THE STUDY OF EXCHANGE REACTIONS IN THE SYSTEMS: FERROUS PICOLINATE HEXAAQUO COMPLEX OF Fe(II) AND FERROUS PICOLINATE PICOLINIC ACID BY USING THE ISOTOPIC TRACER METHOD. Ignacy Zlotowski, Moeczyslaw Zielinski, and Przemyslaw Panta. Nuklenonika, 7: 311-23(1962). (In Polish)

The kinetic properties of the following exchange reactions are investigated by means of tracers: the Fe^{2+} ion exchange between ferrous picolinate and the hexaaquo complex of Fe (II); and the exchange of picolinic ions between ferrous picolinate and picolinic acid molecules. In the first case $Fe(H_2O)$ labeled with Fe^{59} is used, whereas in the second case picolinic acid with a C^{14} atom incorporated into its carboxyl group is used. A method for the preparation of C^{14} carboxyl-labeled picolinic acid is developed that is based on hydrolysis of the respective C^{14}-labeled amide or nitrile obtained from α-bromopyridine. The overall radiochemical yield of the carboxyl-labeled picolinic acid prepared from the labeled amide is approximately 25%. However, using labeled nitrile the yield is as high as 75%. Precipitation is applied as a separation method in the studied exchange systems. In order to separate ferrous picolinate from $Fe(H_2O)_6^{2+}$ ions, several precipitating agents are used, namely ammonia, sodium dihydrogen phosphate, ammonium sulfide, potassium ferricyanide and potassium cobalticyanide. The separation of ferrous picolinate from picolinic acid is carried out by precipitating the latter in the form of slightly soluble copper (II) picolinate. At 20°C the half time for the exchange of Fe^{2+}-ions between ferrous picolinate and $Fe(H_2O)_6^{2+}$ is about one minute, while the exchange rate of picolinic ions between ferrous picolinate and picolinic acid is much greater (<15 sec). The results seem to indicate that the labile ferrous picolinate complex is of the so-called "outer-orbital" type. An analysis of the mechanisms of the studied rerctions is given. (auth)

167 A STUDY OF URANYL NITRATE–UREA–AMMONIA–WATER SYSTEM. Wojciech Dembinski and Andrzej Deptula (Inst. of Nuclear Research, Polish Academy of Science, Warsaw). Nukleonika, 7: 325-39(1962). (In English)

The course of precipitation of products from uranyl nitrate solutions containing urea is investigated, using a potentiometric method. The composition of the products is determined analytically. It is found that a stoichiometric compound $H_2O \cdot UO_3 \cdot 2CO(NH_2)_2$, or ammonium polyuranates containing urea are formed, depending on the precipitation technique and urea concentration. A probable mechanism for the reactions in the investigated system is given. (auth)

168 PARAMAGNETIC SUSCEPTIBILITY OF TERBIUM HEXA-ANTIPYRENE TRI-IODIDE. J. A. White (Harvard Univ., Cambridge, Mass.), H. J. Williams, and R. C. Sherwood. Phys. Rev., 128: 581-3(Oct. 15, 1962).

Terbium hexa-antipyrene tri-iodide has a large temperature-dependent susceptibility parallel to the crystal hexagonal symmetry axis and at low temperatures a very much smaller temperature-independent susceptibility perpendicular to this axis. This behavior is interpreted on a hexagonal crystal field model. The parallel susceptibility, which between 1.4 and 150°K is given by $\chi_{par} = 8.7\ \beta(H_0^2 + H^2)^{-1/2} \tanh [8.7\ \beta(H_0^2 + H^2)^{1/2}/kT]$ with $H_0 = 3400$ Oe, corresponds to a nondegenerate terbium $J_z = \pm 6$ doublet with a zero field splitting of 4°K. The remaining crystal field levels lie more than 150°K above the doublet. The crystal field is found to have strong axial components, with somewhat weaker hexagonal distortions responsible for the doublet splitting. Distortions from hexagonal symmetry, although known to be appreciable in hexa-antipyrene at low temperatures, make only a small contribution to the Tb^{3+} susceptibility. (auth)

169 QUESTION OF THE PARAMAGNETISM OF THE M CENTER IN SODIUM FLUORIDE. Haywood Blum (Univ. of Illinois, Urbana). Phys. Rev., 128: 627-30(Oct. 15, 1962). (TID-16415)

A strong optical absorption band is observed in NaF at 507 mμ, and identified as the M band by Ivey's law and by experiments on formation kinetics and polarization of luminescence by other workers. Not only is a substantial change in the relative intensities of the F and M bands possible in this substance, but also the M band can be made strong compared to the F without the appearance of other bands. The existence of magnetic centers in NaF is studied by means of electron spin resonance. The correlation of resonance intensity with optical studies demonstrates that no paramagnetism arises from the M centers. The optical F band is positively correlated with a resonance line. Resonance lines belonging to an unidentified center are reported, as are lines belonging to paramagnetic impurities. (auth)

170 VARIATIONAL CALCULATION OF THE STERNHEIMER FACTORS FOR THE FERROUS ION. R. Ingalls (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 128: 1155-8(Nov. 1, 1962).

The Sternheimer factors for the ferrous ion are calculated using the free-ion wave functions of Watson and the variational method of Das and Bersohn. The results of this calculation are $R = +0.22$ and $\gamma_\infty = -10.6$. With these factors and previously published ferrous quadrupole splitting data, the quadrupole moment of the first excited state of iron-57 is estimated to be +0.15b. (auth)

171 REVERSIBLE AND IRREVERSIBLE PROCESS OF THE DROPPING MERCURY ELECTRODE. X. La^{+3}, Ce^{+3}, Pr^{+3}, AND Dy^{+3}. J. Sancho, J. Almagro, and V. Almagro (Instituto A. de G. Rocasolano del C.S.I.C., Murcia, Spain). Publ. Inst. Quim. Fis. "Rocasolano," 15: 229-36 (1961). (In Spanish)

A study was made of La^{+3}, Ce^{+3}, Pr^{+3}, and Dy^{+3} ions in carrier solutions: 0.1 M LiCl–25% ethanol; 0.1 M LiCl–50% ethanol; 0.5 M LiCl–50% ethanol; 1.0 M LiCl–50% ethanol; and 0.1 M LiCl–75% ethanol. In all cases only one polarographic wave was found because of an irreversible process ruled by diffusion, although dysprosium approaches reversibility. By means of microcoulombimetric methods it was determined that the number of electrons intervening in the reduction of Dy^{+3} is three. Data of interest for the use of polarographic waves in analytical processes are presented. (auth)

172 ON THE NATURE OF THE ELECTRICAL CONDUCTIVITY OF BERYLLIUM, MAGNESIUM, CALCIUM, AND STRONTIUM OXIDES AT HIGH TEMPERATURES. S. F. Pal'guev and A. D. Neuimin (Electrochemistry Inst.

Academy of Sciences, Sverdlovsk, USSR). Soviet Phys.-Solid State (English Transl.), 4: 629-32(Oct. 1962).

The nature of electrical conductivity in the pure oxides BeO, MgO, CaO, and SrO was investigated by the electromotive-force method. It was found that at 1000 to 1300°C BeO was practically an ionic conductor, regardless of the oxygen partial pressure in the gaseous medium in which the measurements were made. The nature of the conductivity of MgO, CaO, and SrO depended on the oxygen partial pressure in the gas phase: in a cell with gaseous oxygen–air electrodes, SrO displayed overwhelming electronic conductivity; with oxygen–($CO + CO_2$ mixture) electrodes the average transport number of the ions was 0.9; values obtained in these cases for CaO were 0.5 to 0.6 and 0.6 to 0.9, respectively; and corresponding values for MgO were 0.8 to 0.9 and 0.9 to 0.95. The electrical conductivity of the oxides investigated was shown to be amphoteric. (auth)

173 THE THERMODIFFUSION FOR A BINARY MIXTURE OF GASES THROUGH UNGLAZED SPHERES OF EQUAL MASS AND EQUAL DIAMETER. E. Truebenbacher (Max-Planck-Institut für Chemie, Mainz). Z. Naturforsch., 17a: 539-49(July 1962). (In German)

The Boltzmann equation for the model of unglazed spheres was formulated in the approximation of isotropic orientation of the angular velocity of molecules with the introduction of a suitable scattering cross section, and the validity of a detailed balanced relation for this was shown. Using these scattering cross sections and the general theory of gas mixtures from excitable molecules, the thermodiffusion factor of a binary mixture of gases from unglazed spheres was calculated. The formulas thus obtained permit, without any special trouble, the calculation of the diffusion constants of mixtures and of the thermal conductivity of simple gases and therefore comparison with known results. For the special example, D_2 with traces of HT, the thermodiffusion factor was numerically calculated. In comparison with experiment the result has the right sign, but is too small in absolute value by a factor of 15. (tr-auth)

174 POLAROGRAPHIC INVESTIGATION OF THE BOROHYDRIDES OF ALKALI METALS. K. H. Mochalov and G. G. Gil'mashin (Kirov Kazan Inst. of Chemistry and Tech., USSR). Zh. Fiz. Khim., 36: 1089-94(May 1962). (In Russian)

It is shown that $NaBH_4$, KBH_4, $LiBH_4$, and $CsBH_4$ exhibit the same polarographic wave with a potential $E_{\frac{1}{2}} = 0.65$ v. Variations in pH or temperature at 15 to 35°C do not affect the potential magnitude. The wave height is a function of pH. At pH > 12.5 the polarographic wave is absent; it appears with the factors inducing and accelerating hydrolysis (acidification, heating, or catalysis). It is also shown that the borohydride wave in the volt-amp curve does not belong to the BH_4^- ion but to one of the products of hydrolysis, probably to $BH(OH)_3^-$, and must be a hyporeversible. The character of polarographic kinetic curves of $NaBH_4$ and KBH_4 indicates that the hydrolysis of the compounds follows the kinetics of consecutive reactions. (R.V.J.)

175 THE OXIDATION OF URANIUM AND SOME URANIUM COMPOUNDS IN LIQUID AMMONIA. Carl John Kershner. Thesis, Athens, Ohio, Ohio Univ., 1961. 91p.

A study is made to determine conditions and find effective oxidizing agents for accomplishing the oxidation of uranium in liquid ammonia. After establishing suitable systems, the valence state of uranium in the oxidized uranium compound and the composition of this compound are determined. In view of the possibility of the formation of an ammonia system analog to the dioxouranium(VI) ion, an effort is made to identify any uranium(VI) species formed. Precautions are employed to exclude water vapor and air from the reaction systems. All reagents are prepared or purified by methods designed to render them as anhydrous as possible. Hygroscopic or air-sensitive materials are handled and weighed in a dry box under a nitrogen atmosphere. A vacuum line is employed for the manipulation and addition to the reaction vessel of the ammonia solvent and the reactants. Most of the reactions are carried out at room temperature in sealed heavy-walled Pyrex vessels. These reaction vessels are separated into two chambers by a sintered glass disk, which furnishes a means of separating the insoluble and soluble reaction products while the vessel is sealed and free from atmospheric contamination. Microcrystalline uranium metal, UH_3, UO_2, and $U(OAc)_4$ are used as reducing agents and $AgNO_3$, AgI, AgOAc, HgI_2, $Hg(CN)_2$, $CuCl_2$, and CuI are used as oxidizing agents. The reaction products are investigated by chemical, x-ray, and infrared methods. After the products are identified, quantitative studies are made to determine the stoichiometry of the reactions. The only systems that react with high enough rates to be useful for stoichiometric studies are those containing acetate. Both uranium metal and uranium (IV) acetate react with silver acetate to produce silver metal, acetamide, and uranium(VI). In the reaction with uranium metal, evidence is found that indicates that the various oxides of uranium are formed in the course of the reaction. Initially, in both reactions involving uranium metal and uranium(IV) acetate as reducing agents, the oxidized uranium is present as a soluble acetate-complexed species of the dioxouranium(VI) ion, but the acetates associated with the uranium(VI) slowly solvolyze to produce acetamide and the uranium precipitates as solvated ammonium diuranate. The uranium(VI) species in the system containing acetate is formulated as $(NH_4)_2UO_2(OAc)_4$, and two possible mechanisms for the redox reaction between silver acetate and uranium(IV) acetate are given on the basis of the chemical, x-ray and infrared evidence acquired. In the first mechanism, an activated complex $Ag_2U(OAc)_8$ is proposed in which uranium(IV) and silver(I) are bridged by an acetate group. Nucleophilic attack by ammonia on the carbonyl carbon of the bridged acetate is proposed as the mechanism for the production of acetamide and of dioxouranium(VI) ion. The second mechanism proposes an intermediate uranium(V) species, $U(OAc)_5$, which disproportionates and undergoes solvolysis to produce uranium(IV) acetate, acetate-complexed dioxouranium(VI) species, and acetamide. There is no evidence for the formation of an ammonia solvent system analog to the dioxouranium(VI) ion. (Dissertation Abstr., 22: No. 7, 1962.)

176 CATALYSTS FOR CERIUM(IV) OXIDIMETRY. George Gerald Guilbault. Thesis, Princeton, N. J., Princeton Univ., 1961. 161p.

A general, non-specific catalyst system is developed, which extends the scope of cerium (IV) oxidimetry by providing a simple, rapid method for the determination of many difficult oxidizable inorganic and organic substances. The method involves the use of silver (I) and manganese (II) salts as catalysts in conjunction with a perchloric acid solution of cerium (IV) sulfate. The end point of the reaction is indicated by the cherry red color of permanganate, or, in some cases, the cloudiness caused by the incipient formation of manganese (IV) oxide. The rate of reaction using the two catalysts together is greater than that expected by addition of the results for the separate catalysts, indicating an enhanced effect. Rate of oxidation is suffi-

ciently rapid at 90°C that complete reaction takes only 3 to 5 minutes for mercury (I), tellurium (IV), polyhydroxy organic compounds, and 8-quinolinol. Using this method, 10 to 600 mg of mercury (I) may be determined in the presence of 1.0 gram of mercury (II) with a standard deviation of less than 0.3%. Mercury (II) may be reduced to mercury (I) by mercury metal, and then determined by catalytic cerium (IV) oxidation; and mixtures of mercury (I) and (II) in any ratios can be determined in one sample. Fifteen to 100 mg of phosphite, 5 to 35 mg of hypophosphite, and 10 to 100 mg of tellurium may be determined with standard deviations of 0.17, 0.32, and 0.21%, respectively. Organic compounds such as glycerol (3 to 50 mg), erythritol or pentaerythritol (3 to 16 mg) may be determined with a standard deviation of 0.3 to 0.5%; gallium (III), indium (III), aluminum (III), or magnesium (II) (0.05 to 5 mg) may be analyzed after dissolution of the 8-quinolinol precipitates with a standard deviation of 1.0%. Reducing sugars such as glucose, fructose, and sucrose, cellulose, and methyl cellulose may be determined by catalytic oxidation in a water bath at 80°C. Fourteen 30-mg samples may be analyzed with a standard deviation of 0.35%. The titration of several substances with ceric perchlorate reagent is attempted. A direct oxidation of 65 to 510 mg of mercury (I) may be accomplished with a standard deviation of 0.36%. Cellulose and reducing sugars, however, react considerably slower and require back titration. In both the inorganic and organic oxidations, it is found that the rate of oxidation increases with first order dependence on perchloric acid at low acid concentrations, reaches a maximum in 4.0 F, and then decreases. The presence of sulfate, however, inhibits the reaction. It is believed that in each instance a prior equilibrium reaction occurs, involving the formation of the kinetically more favorable $CeSO_4^{2+}$ species. The rate of oxidation of mercury (I) perchlorate by cerium (IV) sulfate in perchloric acid media is found. The dependence of the reaction rate on sulfuric and perchloric acids is discussed in terms of the cerium (IV) species in solution. A reaction mechanism is proposed in which the rate-determining step is believed to involve concomitant breaking of the $(Hg-Hg)^{2+}$ bond and electron transfer. The energy of activation for this reaction is 14.4 kcal per mole. The rates of the silver (I), the manganese (II), and the silver (I)–manganese (II) catalyzed oxidations of mercury (I) by cerium (IV) in perchloric and sulfuric acids are studied at 50.0°C. Activation energies are 13.55, 12.10, and 10.05 kcal per mole, respectively. Enhanced catalytic effects are observed in perchloric acid, but a mere additive effect is obtained in sulfuric acid. Reaction mechanisms are proposed in which Ag^{2+} and Mn^{2+} are believed to be active intermediates in breaking the $(Hg-Hg)^{2+}$ bond. The oxidation of glycerol by cerium (IV) proceeds by two different mechanisms, depending upon the nature of the acid used. In sulfuric, the $CeSO_4^{2+}$ species first forms in a prior equilibrium step, and then oxidizes glycerol by bond breaking via a free radical mechanism. The kinetic expression is found. In perchloric acid, however, it appears that a [Cerium (IV)–Glycerol] complex first forms, followed by disproportionation as the rate-determining step. (Dissertation Abstr., 22: No. 7, 1962.)

177 HYSTERESIS EFFECTS AND THE STOICHIOMETRY OF PRASEODYMIUM OXIDE. Paul Alfred Faeth. Thesis, Lafayette, Ind., Purdue Univ., 1961. 261p.

It is demonstrated that water and CO_2 have a detrimental effect on freshly prepared samples of PrO_x as far as an infrared interpretation is concerned. X-ray analyses conducted in conventional ways are considered to be subject to some error as a result of atmospheric contamination. The atmospheric contamination of oxide samples is shown to result in the formation of species whose infrared spectra resemble those of praseodymium carbonate and praseodymium hydroxide. An absorption band at about 15 microns is thought to be a result of the carbonation-hydration effects. The band is considered as indicative of a metal-oxygen bond. The resistance (R) of praseodymium oxide (in vacuo) is reported over five orders of magnitude as a function of the temperature. It is shown that the resistance of a sample of oxide decreases as the temperature is increased to about 700°C, and then increases as the temperature is raised to 920°C. At 920°C, it is believed that a phase transition takes place, most likely the cubic to hexagonal transformation of Pr_2O_3; another phase change is believed to occur at about 700°C. Plots of log R versus 1/T are linear and energies are calculated from the slopes; a change in the sign of the slope at 700°C is observed. Association pressures (P_B) between Pr_2O_3 and O_2 are measured; a break in the linear log P_B versus 1/T plots occurs at 920°C; this evidence is used as additional support for the argument that a phase change occurs at 920°C. An additional break is noted in the curve at 745°C and is believed to indicate the other phase change found in the resistance studies. The energies of the two transitions are 12 and 20 kcal, respectively. Isotherms are measured from 400 to 1000°C and from 10^{-5} to 150 mm Hg of oxygen pressure. A quartz beam microbalance provides a continuous monitor of the change of composition with pressure. The isotherms agree with those obtained by a volumetric measuring technique. An analysis of the isotherms shows that hysteresis effects are present between adjacent, apparently stable stoichiometries. The stable stoichiometries have no simple formulas, however. Homologous series are suggested, which qualitatively account for the observed regions of stability. The hysteresis loop at 465°C is analyzed and compared with seven theorems proposed in a general theory of hysteresis. A high degree of correspondence is observed between the Pr–O system and the domain system proposed in the theory. An analysis of the interior of the hysteresis loop region at 465°C further substantiates the agreement between the theory and the Pr–O system. The correspondence leads to a consideration of the Pr–O system as being composed of domains of PrO_x. A model and mechanism are postulated, which agree qualitatively with experimental observations. (Dissertation Abstr., 22: No. 7, 1962.)

178 PERTURBATION OF THE VIBRATION-ROTATION SPECTRA OF HCl^{35} IN THE PRESENCE OF RARE GASES. Willard B. Birtley. Thesis, University Park, Penna., Pennsylvania State Univ., 1961. 59p.

The shift in frequency of molecular band lines in the 2-0 band of HCl^{35} and of the $\nu_1 + \nu_3$ band of C_2H_2 as a result of the presence of krypton and xenon was investigated. Measurements showed a pronounced dependence of the shifts on the rotational quantum number J. The relative shifts in the upper and lower states of the transitions were calculated from the shifts of the $\Delta_2F''(J)$ and $\Delta_2F'(J)$ values obtained from the measured line shifts. In the case of HCl^{35} the shifts in the rotational levels were markedly different in the upper and lower states, the upper state being approximately proportional to J, while the lower state energy-level shifts approached an asymptotic value for high J. The spectral line shifts of the $\nu_1 + \nu_3$ band of C_2H_2 were not too dissimilar from the observed line shifts of HCl^{35}, even though HCl^{35} had a large permanent dipole moment, as opposed to C_2H_2 which had a zero permanent dipole moment. The shift of the R(10) line of the 2-0 band of HCl^{35} by the perturbing effect of the foreign gases helium, neon, argon, krypton, and xenon was observed. A definite and possibly linear dependence of the observed shifts to the polarizabil-

ity of the perturbing gas was noted. It was found that the line shifts were independent of the gas temperature and linear with the gas density for pressures up to one atmosphere. Precise measurements were made of the frequencies of the 2-0 band lines of HCl^{35} in both the P and R branches to J = 17. The band origin was determined, as were the rotational constants B_v, D_v, and H_v, for the upper and lower vibrational states. The shape of absorption lines of HCl^{35} and C_2H_2 broadened with krypton and xenon as foreign gases was shown to have a Lorentz contour resulting from collision broadening. Corrections for instrumental width were made to determine the half-intensity width. These widths showed a small J dependence, with low J lines being the broadest. No difference between the widths of P and R branch lines of the same J could be detected. The breadth of HCl^{35} and C_2H_2 lines were not markedly different despite their difference in permanent dipole moment. No asymmetry of lines perturbed by krypton and xenon could be observed. (Dissertation Abstr., 22: No. 7, 1962.)

179 FIZICHESKAYA KHIMIYA RASPLAVLENNYKH SOLEI I SHLAKOV. TRUDY VSESOYUZNOGO SOVESHCHANIYA PO FIZICHESKOI KHIMII RASPLAVLENNYKH SOLEI I SHALAKOV, (22-25 NOYABRAYA 1960 G.). (Physical Chemistry of Molten Salts and Slags. (Reports of the All-Union Conference on Physical Chemistry of Molten Salts and Slags, Urals, 22-25 November, 1960)). Moscow, Metallurgizdat, 1962. 480p.

Fifty-five papers are included on the physico-chemical properties of molten salts used in Be, Zr, Hf, Ti, Al, and Mg metallurgy and electrochemistry. The papers deal with the thermodynamics of molten salts, kinetics of electrode processes, and equilibrium in salt-metal systems. Reports are also given on physical properties of molten slags in ferrous and nonferrous metallurgy and diffusion and equilibrium in slag-metal systems. (R.V.J.)

Organic Chemistry

180 (TID-16862) ELECTROCHEMISTRY IN PYRIDINE. II. POLAROGRAPHIC BEHAVIOR OF BENZOPHENONE. Report No. 72. Andrzej Cisak and Philip J. Elving (Michigan. Univ., Ann Arbor). Aug. 15, 1962. Contract AT(11-1)-1148. 10p.

The polarographic reduction of benzophenone at the dropping Hg electrode was investigated in 20% to 100% pyridine solution with particular attention to the nature of the electrolytic process in dry pyridine. In the latter solvent, benzophenone is reduced in an apparently one-electron reversible process to an anion free radical, which would readily dimerize to a product, which would in turn hydrolyze in the presence of water to form benzpinacol. The reduction mechanism is thus generally similar to that of benzophenone in alkaline aqueous solution, where the relative lack of H ion results in an anionic free radical being the primary product. (auth)

181 (TID-17019) PREPARATION OF PLASTIC SCINTILLATORS. PART I. PREPARATION AND EVALUATION OF SCINTILLATION PLASTICS CONTAINING ORGANOMETALLIC COMPOUNDS FOR GAMMA DETECTION. PART II. COPOLYMERIZATION OF TRIPHENYLTIN STYRENE AND TRIPHENYLLEAD STYRENE WITH STYRENE AND VINYL TOLUENE. Progress Report No. 8, March 1, 1962–July 31, 1962. K. C. Tsou, S. R. Sandler, and J. E. Dannin (Borden Chemical Co. Central Research Lab., Philadelphia). Contract AT(30-1)-1930. 66p.

Several organometallic compounds were incorporated into scintillation plastics. Fabrications from triphenyl-lated styrene and dimethyl styrene were the most efficient and produced the best peak resolution. Triphenyl(4-ethyl)phenyllead was found to be a very good organometallic solute. In other work, triphenyltin styrene and styrene were studied to obtain characteristics concerning homopolarization. (J.R.D.)

182 (JPRS-15432) THE CHEMISTRY AND APPLICATION OF ORGANOPHOSPHORUS COMPOUNDS. A. E. (Ye.) Arbuzov, ed. Translation of "Khimiya i Primeneniye Fosfororganicheskikh Soyedineniy" (A publication of the Publishing House of the Kazan' Affiliate of the Academy of Sciences USSR, Moscow, 1962). 1165p.

Papers presented at the Second Conference on the Chemistry and Use of Organophosphorus Compounds in Kazan' on November 26 to December 1, 1959, are given. Topics covered include: preparation of new classes of organophosphorus compounds and the establishment of the structure of many of them, the physiological activity of organophosphorus compounds, the production of monomers and polymers based on these compounds, and plant protection using organophosphorus insecticides. (M.C.G.)

183 (JPRS-15432(p.983-9)) THE USE OF SOME ORGANOPHOSPHORUS COMPOUNDS AS THERAPEUTIC AGENTS AND PROPHYLACTICS IN RADIATION SICKNESS. N. A. Loshadkin, S. M. Markov, and F. L. Maklyayev. Translated from p.520-3 of "Khimiya i Primeneniye Fosfororganicheskikh Soyedineniy" (A publication of the Publishing House of the Kazan' Affiliate of the Academy of Sciences USSR, Moscow, 1962).

The effects of the anticholinesterace compound ethoxy-p-nitrophenyl ester of ethyl-phosphinic acid (armin) on radiation sickness were investigated. The experiments were conducted on 300 white mice. The animals were irradiated to a dose of 780 ± 26 r. Armin was administered subcutaneously 10 min before irradiation; after 1 hr; and 1, 2, 3, and 4 days following irradiation. It was found that armin produces a beneficial effect, especially when administered 2 and 3 days after irradiation. An investigation was also begun on the protective action of some organic derivatives of phosphorous acid (diamyl and di-isoamyl phosphites). A very slight protective effect was observed. (M.C.G.)

184 THE REACTIONS OF METHYLENE. VI. THE ADDITION OF METHYLENE TO HYDROGEN AND METHANE. Jerry A. Bell and G. B. Kistiakowsky (Harvard Univ., Cambridge, Mass.). J. Am. Chem. Soc., 84: 3417-25(Sept. 20, 1962).

The initial step in the reaction of methylene with hydrogen and methane is primarily an addition to form, respectively, vibrationally excited methane and ethane. These activated molecules are either stabilized by collisions or dissociate to give free radical fragments. The activated methane dissociates to a methyl radical and a hydrogen atom and the ethane to two methyl radicals. The reaction with hydrogen is approximately one-sixth as rapid as the reaction with carbon–carbon double bonds. Calculations based on the mode of decay of the excited methane molecule give $D(CH_2-H) \geq 104$ kcal/mole. Comparison of the lifetime of the ethane formed from methylene and methane with that produced by association of methyl radicals yields a second value, $D(CH_2-H) = 103 \pm 6$ kcal/mole. Combination of the present results with others recently obtained spectroscopically and thermochemically suggest $D(CH_2-H) = 105 \pm 3$ kcal/mole and, hence, $D(CH-H) = 108 \pm 3$ kcal/mole. (auth)

185 SPIN DENSITIES IN THE CYCLOHEXADIENYL FREE RADICAL. Hanns Fischer (Deutsches Kunststoff-Institut, Darmstadt, Ger.). J. Chem. Phys., 37: 1094-6 (Sept. 1, 1962).

The spin densities in the cyclohexadienyl free radical are calculated using valence-bond and molecular-orbital approximations. The theoretically obtained values are in reasonable agreement with the spin densities derived from the electron spin resonance spectrum of this radical in irradiated benzene. (auth)

186 SYNTHESIS OF p-BENZOHYDROQUINONE-1, 3, 5-C_3^{13}. M. R. Das, M. P. Khakhar, and M. V. Krishnamurthy Tata Inst. of Fundamental Research, Bombay and Atomic Energy Establishment, Trombay, India). Proc. Indian Acad. Sci., Sec. A, 103-7(Aug. 1962). (In English)

p-$C_6H_4(OH)_2$ with C^{13} labeling of the 1, 3, and 5-C atoms was synthesized in order to observe the C^{13} hyperfine splittings of the electron spin resonance spectra of the semiquinone ions. The synthesis involved converting $BaC^{13}O_3$ to pyruvic-2-C^{13} acid and cyclization. (D.L.C.)

187 UBER DIE VERWENDBARKEIT VON o-, m-, UND p-OLIGOPHENYLENEN ALS SOLUTE FLÜSSIGER SZINTILLATOREN. (The Usefulness of o-, m-, and p-Oligophenylenes as Solutes for Liquid Scintillators). Uwe Nay. Thesis, Mainz, Johannes Gutenberg Universität, 1962. 1p.

Forty-six compounds, principally p-, o-, m-oligophenylenes and 1,3,5-triaryl substituted benzenes were measured with respect to the mean fluorescence wavelength and relative maximum pulse height under standard conditions; this permitted a direct comparison with corresponding literature values. Only the p-oligophenylenes in their maximum relative pulse heights are more than 10% better than the usually used standard PPO. Three compounds were found to be suitable for counting at low temperatures. It could be shown that for a good scintillation capacity coplanar standardization possibilities of the molecules are necessary. The maximum relative pulse height decreases according to the weight of the steric rotational hindrance. (tr-auth)

Radiation Chemistry and Radiochemistry

188 (AERE-R-3989) THE RADIATION AND THERMAL STABILITY OF SOME POTENTIAL ORGANIC MODERATOR-COOLANTS. PART VI. THE EFFECT OF TEMPERATURE ON THE RADIOLYSIS OF BIPHENYL, ISOPROPYL BIPHENYL, METATERPHENYL AND SANTOWAX R. W. G. Burns, C. R. V. Reed, R. W. Wilkinson, and J. A. Winter (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Aug. 1962. 32p.

Two kinds of investigation are reported. Biphenyl, irradiated with fast electrons and pile radiation, and isopropyl biphenyl, with pile radiation only, were radiolysed to low percentage conversions from 100–400°C. In the region 400–420°C, the radiolysis of Santowax R and metaterphenyl was studied. In the case of biphenyl under electron irradiation, and of isopropyl biphenyl under pile radiation plots of $\log_{10}$ G(→ HBR) against 1/T gave a straight line with a low activation energy of < 1 kcal/mole. In all other cases the curves of $\log_{10}$ G(→ HBR) and $\log_{10}$ G(gas) against 1/T showed an increasing steepness with rising temperature. At low temperatures all gave slopes corresponding to a low (< 1 kcal/mole) activation energy. At higher temperatures the gas G values increased more rapidly than the values of G(→ HBR), except at the highest temperatures with metaterphenyl and Santowax R. With metaterphenyl and Santowax R at ~ 400°C the value of G(→ HBR) increased very steeply with temperature. The increase was greater than that to be expected from the simple addition of the thermal reaction, although in the absence of radiation this would not be negligible. The products were in some respects similar to those obtained from thermal decomposition, and the onset of a different mode of radiolysis is indicated. (auth)

189 (BNL-753) RADIATION PROCESSING REPORT NO. 5 — COBALT-60 GAMMA IRRADIATION OF URANIUM AND HYDROCARBONS. Peter Colombo and Meyer Steinberg (Brookhaven National Lab., Upton, N. Y.). Aug. 1962. Contract [AT(30-2)-Gen-16]. 18p.

Gamma radiation from a Co^{60} source was used to react uranium, uranium hydride, and uranium oxide with propane and other hydrocarbons in an attempt to form uranium monocarbide. A series of survey experiments was undertaken to determine the effect of temperature, concentration, and total dose. The carbide concentration was determined by chemical and x-ray analysis. With propane gas in excess of stoichiometric quantity, and at pressures up to 7 atm. and room temperature, the conversion to carbide varied between 0.6% and a maximum of 5.0%. Increasing the hydrocarbon concentration to five times the stoichiometric amount had no effect on the yield through a range of radiation doses up to 80 million rads. At 350°C in the absence of radiation a conversion in the order of 5% was observed; the addition of the gamma radiation at 350°C gave no apparent increase in conversion. Radiation experiments with propane and hydrided uranium at room temperature gave conversions of the same order of magnitude as those with dehydrided uranium. The yields resulting from the use of the liquid hydrocarbons dimethylbutane and methylpentane were no higher than the yield from the propane experiments. However, hexane did give a higher yield than propane. It appeared that over the range of conditions stated Co^{60} gamma radiation has a negligible effect in promoting the formation of uranium carbide from uranium and hydrocarbons. The low G values indicate a nonchain type reaction mechanism. (auth)

190 (CEA-2166) APPLICATIONS RADIOCHIMIQUES DES COLONNES DE PRECIPITES DE SULFATES INSOLUBLES.- Contribution à l'Étude des Solutions Vieillies de Produits de Fission. (Radio-Chemical Applications of Columns of Precipitated Insoluble Sulphates. Contribution to the Study of Fission Product Solutions). M. Barrachina (Spain. Junta de Energiá Nuclear, Madrid) and R. Sauvagnac (France. Commissariat à l'Energie Atomique. Centre d'Études Nucléaires, Saclay). 1962. 42p.

Preparation of $SrSO_4$ and $BaSO_4$ columns is described and variables affecting fixation of Sr^{90} such as pH, SO_4^{--} concentration, column density, flow rate, and use of the EDTA complex are studied. A mechanism is proposed for the exchange and fixation. The fixation of rare earths in the absence or presence of EDTA was studied. It was observed that for nitrate or chloride concentrations of over 2 mg/ml, or in the presence of stronger than 1N HNO_3 or HCl, Ba was fixed selectively. These results were applied to radiochemical separations in fission product solutions for Ba^{140} and Sr^{90}, and separation of the ceric earth group and the yttric earth group. (auth)

191 (IA-735) APPLICATION OF RADIOISOTOPES IN LUMINOUS DEVICES. PART II. TRITIATED POLYMERS. A. Heller and M. Anbar (Israel. Atomic Energy Commission, Rehovoth). July 1962. 13p.

Methods for the incorporation of high activities of tritium in organic polymers, which serve as paint-bases for luminous paints are described. Tritium can be introduced by simple procedures quantitatively in some polyesters and polyurethanes. (auth)

192 (JEN-105-DQ/I/32) APLICACIONES RADIOQUIMICAS DE LAS COLUMNAS DE PRECIPITADOS DE SULFATOS INSOLUBLES. CONTRIBUCIÓN AL ESTUDIO DE LAS SOLUCIONES ENVEJECIDAS DE PRODUCTOS DE FISIÓN. (Radiochemical Applications of Insoluble Sulfate Columns. Analytical Possibilities in the Field of the Fission Product Solutions). M. Barrachina and R. Sauvagnac (Spain. Junta de Energia Nuclear, Madrid). 1962. 28p.

The heterogeneous ion-isotopic exchange column is used to determine the radiochemical composition of raw solutions used in the industrial recuperation of long-lived fission products. The separation of the radioelements is made by small columns, 1–3 cm height, of $BaSO_4$ or $SrSO_4$, under selected experimental conditions. These columns behave like inorganic exchangers, working by adsorption or ion-isotopic exchange depending on the cases, and they provide selective separation of fission products employing very small volumes of fixing and eluting solutions. By coupling the separative capabilities of these columns and the liquid–liquid extraction with the 2-thenoyltrifluoroacetone and the di-2 ethylexyl orthophosphoric acid, a set of new radiochemical methods, for the determination of Sr^{90}, Y^{90}, $Ce^{144}-Pr^{144}$, and Pm^{147} in the fission product solutions of Marcoule, were developed. (auth)

193 (LAMS-2756) PREPARATION OF NEPTUNIUM-237 METAL. A. N. Morgan, K. W. R. Johnson, and J. A. Leary (Los Alamos Scientific Lab., N. Mex.). Sept. 5, 1962. Contract W-7405-eng-36. 13p.

The preparation of three lots of neptunium-237 metal is described. On the 15–20 g scale, reduction with Ca in CaF_2 crucibles resulted in an average yield of 97 percent. The metal products were remelted and cast into a 0.24 in. dia. cylindrical ingot, then machined into a rod 0.230 in. dia. × 1.156 in. long. Density of this rod was 20.34 g/cc. Results of thermal analysis and reaction of metal with various acids also are discussed. (auth)

194 CHANGES IN CERTAIN PROPERTIES OF MOTOR FUELS FROM THE EFFECT OF GAMMA AND X-RAYS. Z. Tamási. Acta Chim. Acad Sci. Hung., 31: 235-42(1962). (In German)

The effects of irradiation doses by gamma and x rays up to 10^5 r at 17 and 40°C, respectively, on the physical and chemical characteristics of motor fuels, including motor car and aircraft gasolines of Hungarian and foreign origin, and the gasoline, kerosene and gas oil distillates of the Lispe crude oil, were investigated. Further, it was examined whether the irradiated fuels are suitable for use. As a radiation source, Co^{60} and an x-ray generator of 250 kv nominal potential were applied. In addition to the control of the characteristics of crude oil products according to Hungarian standards, also the measurement of fluorescence was first applied for the characterization of motor fuels. From the data, the following conclusions can be drawn: Already on the effect of irradiations by gamma and x rays up to 10^5 r, perceptible alterations occur in motor fuels. The extent and direction of these alterations depend on the composition of the petroleum products. The alterations did not exceed, in general, those taking place during careless storage and keeping for 1 to 2 years. However, marked deteriorations occurred in the octane number, acidity and storability of the irradiated gasolines. Under the studied conditions, the occurring alterations did not prevent the further use of irradiated motor fuels. A new highly sensitive method, based on measuring the percentage of fluorescence, was evolved for the investigation of irradiated motor fuels. (auth)

195 THE CHEMILUMINESCENT METHOD OF MEASURING THE RATIO OF REACTION RATE CONSTANTS IN THE LIQUID-PHASE OXIDATION OF HYDROCARBONS. R. F. Vasil'ev and A. A. Vichutinskii (Inst. of Chemical Physics, Academy of Sciences, USSR). Doklady Akad. Nauk SSSR, 145: 1301-4(Aug. 21, 1962). (In Russian)

Hydrocarbon radicals formed by irradiation can react with oxygen to give peroxy radicals which recombine with high luminescence yields. It was found that most hydrocarbon radicals are quickly replaced by peroxy radicals at very low concentrations of O_2 in the system. The concentration of O_2 in a system can be determined by measuring the time required for a decrease in luminescence to be observed. It is shown that the ratio of two reaction rates between radicals can be determined by plotting the reaction time t_{fall} (time required to observe a decrease in luminescence) as a function of the concentration of the hydrocarbon. The ratio of the two reaction rate constants determines the rate of oxidation of a given hydrocarbon and is an important kinetic characteristic of the substance. Measuring the kinetics of the luminescence intensity can be used to determine the ratio of two reaction rate constants and the relative effectiveness of an oxidation inhibitor. (TTT)

196 THE STATIONARY ELECTROCHEMICAL PROCESS IN THE IRRADIATED SYSTEM Pt | H_2SO_4 SOLUTION | Au. G. Z. Gochaliev, Ts. I. Zalkind, and V. I. Veselovskii (Karpov Inst. of Physical Chemistry, USSR). Dokl. Akad. Nauk SSSR, 146: 131-4(Sept. 1, 1962). (In Russian)

An irradiated solution is considered as a solution of products which can be electrochemically reduced (the oxidation products of radiolysis) and electrochemically oxidized (the radiolytic reduction products). The rates of oxidation and reduction at the electrodes balance out ($I_{red} = I_{ox}$), and the external current is zero with a Pt electrode. On introducing a gold electrode into the irradiated solution, an external current will occur in the external circuit due to the difference in potential between Pt and Au: $I_{st} = (I_{red} - I_{ox})_{Pt} = (I_{ox} - I_{red})$ Au. On irradiating an 0.8N H_2SO_4 solution containing Pt and Au electrodes, it was observed that the Au electrode undergoes significant polarization, while the Pt potential varies only by 20 to 30 mv. On one part of the polarization curve, the current does not depend on the difference in potential between the Pt and Au, but depends linearly on the dose rate over the interval of 2×10^{15} to 4×10^{16} ev/ml-sec. This property can be used as a dosimeter of gamma radiation. (TTT)

197 THE EFFECTS OF IONIZING RADIATIONS ON L-, DL-PHENYLALANINE AND L-, DL-TRYPTOPHANE STUDIED BY ULTRA-VIOLET AND INFRA-RED SPECTROPHOTOMETRY. K. S. Korgaonkar and R. B. Donde (Indian Cancer Research Centre, Bombay). Intern J. Radiation Biol., 5: 67-77(Apr. 1962). (In English)

Aqueous solutions of L-, DL-phenylalanine and L-, DL-tryptophane were irradiated with Co^{60} γ rays. Marked changes in the ultraviolet spectra of the samples and in the infra-red spectra of their solid residues were noted. The radiosensitivities of these irradiated molecules in terms of G-values were determined, and the modes of action and the nature of irradiation products are discussed. A common order of radiosensitivities among the three aromatic amino acids both L-, and DL-forms is observed. Apparent differences in the ultraviolet spectral responses of tryptophane on the one hand and phenylalanine and tyrosine on the other are explained. Evidence is presented suggesting some common radiation end-product of a cellulose or sugar type from these aromatic amino acids. (auth)

198 EFFECTS OF IONIZING RADIATION ON CATALYTIC DEHYDRATION OF N DODECYL ALCOHOL. V. I.

Spitsyn, G. N. Pirogova, and I. E. Mikhailenko (Inst. of Physical Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Otd. Khim. Nauk, No. 9, 1515-20(Sept. 1962). (In Russian)

Studies of n-dodecanol dehydration on pure Al_2O_3 and Parkerized Al_2O_3 in radioactive catalyst indicated a maximum yield of α-dodecyl for n-dodecanol d_4^{20} 0.8286 and n_D^{20} 1.4390. Nuclear reactor (2 days) treatment of Al_2O_3 diminished the catalytic activity, while prolonged (30 days) treatment increased it. Additions of Ce^{144} to Al_2O_3 speed the rate of n-dodecanol dehydration and α-isomerization. Additions of Ce^{144} to Parkerized Al_2O_3 increased the yield of unlimited hydrocarbons, while isomerization remained unchanged. Fast electron irradiation of Al_2O_3 and alcohol vapors increased the rate of dehydration and isomerization. Increased α-dodecane yield at lower temperatures can be achieved with Cs^{137} admixtures to Al_2O_3. (R.V.J.)

199 PREPARATION OF HIGH-DISPERSION METALS AND OXIDES BY RADIATION METHOD. G. M. Zhabrova, B. M. Kadenatsi, T. S. Azizov, V. A. Gordeeva, P. Ya. Glazunov, and A. A. Gezalov (Inst. of Chemical Physics, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Otd. Khim. Nauk, No. 9, 1690-2(Sept. 1962). (In Russian)

High-dispersion oxides and metals prepared at low-temperature by radiochemical processes are analyzed. It is shown that prepared oxides and metals exhibit higher specific surface potentials than those prepared by thermal disintegration. (R.V.J.)

200 CONSECUTIVE ION-MOLECULE REACTIONS IN METHANE. S. Wexler and N. Jesse (Argonne National Lab., Ill.). J. Am. Chem. Soc., 84: 3425-32(Sept. 20, 1962).

Reactions of positive ions with methane molecules were studied at pressures of up to a few tenths of a millimeter in the source chamber of a mass spectrometer. Evidence indicates that increasingly heavy ions are formed in a chain of consecutive reactions between ions and the methane molecules. Some specific chains of such reactions are suggested. The two secondary ions CH_5^+ and $C_2H_5^+$ account for more than 70% of the total ion intensity at higher CH_4 concentrations. Cross sections for the reaction of primary ions with CH_4 were determined from the exponential attenuations of the intensities of the individual species with increasing gas concentration. Reaction cross sections of the principal secondary ions were estimated from the concentration dependences of the intensities of the secondaries. The resulting cross sections of the primaries agree reasonably well with those determined elsewhere by different methods. The results of the measurements are correlated with the ionic mechanism proposed for the reactions occurring in the radiolysis of CH_4. (auth)

201 THE EFFECT OF H_2O ON THE γ-RADIOLYSIS OF AERATED CH_3OH. Norman N. Lichtin, Lynn A. Rosenberg, and Masashi Immamura (Boston Univ.). J. Am. Chem. Soc., 84: 3587-9(Sept. 20, 1962).

Radiolysis of aerated CH_3OH produced no peroxide until ~0.5 wt % H_2O was added; the $G(H_2O_2)$ then jumped from practically zero to the plateau value of 2.8. Several possible explanations of this phenomenon are considered. The H_2O addition did not affect the production of ethylene glycol (G = 0), HCO_2H (1.8 ± 0.2), and CH_2O (10 ± 1). (D.L.C.)

202 THE DETERMINATION OF VERY LOW SPECIFIC ACTIVITIES OF SOLUTIONS. Frantisek Behounek (Czech. Tech. Univ., [Prague]). Jaderna Energie, 8: 189-93(1962). (In Czech.)

Problems of measurement of very low specific activities of solutions are discussed from the point of view of the aim and of the methods used and with respect to some studies. (auth)

203 THE DETERMINATION OF LOW SPECIFIC ACTIVITIES IN THE SOLUTION. Jarmila Ralkova (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, [Prague]). Jaderna Energie, 8: 281-4(1962). (In Czech.)

A reply is made to the article, "The Determination of Low Specific Activity in Solutions," (Jaderna energia, 8: 189-193, June 1962). (P.C.H.)

204 RADIATION-INDUCED VULCANIZATION OF RUBBER IN THE LATEX STATE. D. M. Sandomirskii, V. L. Karpov, and V. G. Yurkevich. Vysokomolekul. Soedin., 4: 1064-70(July 1962).

The effect of ionizing radiation on concentrated natural and synthetic latexes was investigated. Comparison of the properties of films vulcanized by irradiation at the dry and the latex stage showed that structure formation is accelerated in latex owing to the effect of the radiolysis of water, the energy being transferred to the polymer either by the free radicals H^0, OH^0, HO_2^0, etc., or by excited water molecules. Irradiation improved the physical and mechanical properties of some films (optimum dose, 20 mrad) and deteriorated those of other films. Because the latter were already cross-linked and further cross-linking lowers their strength, it was concluded that radio-induced vulcanization should be applied only to rubbers with linear molecules. An increase of the radiation dose lowered the yield of cross-links per 10 ev of radiation in natural latex but increased it in synthetic latex. The nature of the substances contained in the protective films of globules was shown to affect the vulcanization process. The effect of irradiation on latexes as colloidal systems was found to depend on the concentration and nature of the latex. Irradiation caused gelation of some latex, as well as aggregation of the globules and an after-effect (increase of viscosity during storage) in other latex. The last two phenomena indicate the possibility of interglobular link formation under the effect of irradiation. (OTS)

205 THE THERMAL ANNEALING OF NUCLEAR RECOIL DEFECTS IN NEUTRON-IRRADIATED CRYSTALLINE Ir(IV) AND Os(IV) HEXAHALOGEN COMPLEXES. W. Herr, K. Heine, and G. B. Schmidt (Universität, Cologne; Institut für Radiochemie der Kernforschungsanlage, Julich, Ger.; and Max-Planck-Institut für Chemie, Mainz). Z. Naturforsch., 17a: 590-6(July 1962). (In German)

206 SULFURIZATION OF HYDROCARBONS UNDER THE INFLUENCE OF Co^{60} GAMMA RADIATION. Helmut Barzynski and Dieter Hummel (Universität Cologne). Z. Physik. Chem. (Frankfurt), 33: 352-68(Aug. 1962). (In German)

Hydrocarbons react, under the influence of ionizing radiation, with sulfur to form polysulfides. The reactivity of aliphatic and olefinic hydrocarbons is significantly greater than that of aromatic hydrocarbons. For explanation of the reaction mechanism, the reaction of cyclohexane with sulfur and the reaction of hydrogen sulfide with cyclohexylmercaptan were investigated more closely. In addition to the sulfur-containing reaction products (polysulfides, disulfides, thioether, mercaptans, and hydrogen sulfides), radiolytic products of the pure cyclohexane, above all cyclohexene and dicyclohexyl, were formed in large amounts. (tr-auth)

207 RADIOLYSIS OF SULFURIC ACID SOLUTIONS OF DIETHYL ETHER IN THE PRESENCE OF OXYGEN. V. V. Saraeva and A. V. Vannikov (Moscow State Univ.). Zh. Fiz. Khim., 36: 933-6(May 1962). (In Russian)

The effect of x rays on aqueous solutions of diethyl ether in the presence of oxygen was investigated. The yield of H_2O_2 is independent of the ether concentration within the limits 1.10^{-3} to 1M, but the yield in aldehyde varies. In the

presence of sulfuric acid in concentrations up to 0.1M the yield of aldehyde diminishes and that of the peroxide increases, owing to the reaction of HSO_4^- with the OH radical. In concentrated H_2SO_4 solutions of 1 to 4M the yield of carbonyl compounds increases, the increase being greater the higher the concentration of ether and acid. (auth)

208 COMPOSITION OF THE GASEOUS PRODUCTS OF STARCH RADIOLYSIS. V. F. Oreshkov, L. F. Gorin, and N. V. Rudenko (Moscow Inst. of Food Tech.). Zh. Fiz. Khim., 36: 1084-5(May 1962). (In Russian)

Irradiation of potato starch (with 16.4% moisture) in the atmosphere with Co^{60} γ rays to 12 to 20 Mr at 2000 r/min produced a 1:1 ratio of hydrogen to carbon dioxide, indicating destructive spallation of glucopyranose rings. It is postulated that the terminal groups spallate forming pentose residues and formaldehyde, which in turn are oxidized by oxygen into formic acid. Under γ radiation the latter spallates into 1:1 hydrogen and carbon dioxide. (R.V.J.)

209 ACTIVATION OF AN ALUMOSILICATE CATALYST BY PROTONS AND COBALT^{60} IRRADIATION. G. M. Panchenkov, V. I. Yakovlev, L. L. Kozlov, Yu. M. Zhorov, and D. A. Kuzovkin (Moscow Inst. of Oil and Gas Tech.). Zh. Fiz. Khim., 36: 1113(May 1962). (In Russian)

The behavior of aluminosilicate (12.8% Al, 87.10% SiO, and Fe_2O_3) catalyst in isopropylbenzene cracking following proton or Co^{60} γ irradiation was studied. The isopropylbenzene transformation for a given proton-irradiated catalyst is 25 to 40% higher than for non-irradiated and is 77 to 93% higher with a γ-irradiated catalyst. (R.V.J.)

210 RADIOAKTIVNYI STRONTIUM. (Radioactive Strontium). G. V. Korpusov and S. N. Oziranev. Moscow, Gosatomizdat, 1961. 36p.

Data are given on the production, applications, and properties of strontium. Purification, identification, and measurements of radioactive strontium are analyzed. (R.V.J.)

211 DECONTAMINATION OF SOME SELECTED RARE EARTH ISOTOPES AND THE GAMMA RADIATIONS OF HAFNIUM-172 AND -173. George Price Bowman, Jr. Thesis, Columbus, Ohio, Ohio State Univ., 1961. 143p.

For the study of alpha instability among rare earths, chemical procedures involving Dowex-50 cation-exchange resin were used for the purification of samples of neodymium-144 and -146, dysprosium-156, and erbium-162. Samarium decontamination factors were determined to be 5×10^{-6} for neodymium, $\leq 3 \times 10^{-6}$ for dysprosium, and $\leq 10^{-6}$ for erbium. Carrier-free procedures were used for the isolation of hafnium and lutetium from irradiated ytterbium oxide targets. Both anion- and cation-exchange resins were involved. A procedure for measuring the gamma radiations from hafnium isotopes, while continuously or intermittently removing lutetium daughter isotopes, was used. The hafnium was adsorbed onto a small anion-exchange column. When this column was mounted between scintillation crystals, elution with concentrated hydrochloric acid removed the lutetium daughter. This provided a chemical purification of the adsorbed hafnium without disturbing the counting geometry. Coincidences between gamma rays appearing in the decay of hafnium-172 were measured with a 200-channel pulse-height analyzer. The lutetium daughter resulting from orbital electron capture was removed prior to each measurement. Coincidence measurements were made on a pure lutetium-172 sample. Coincidences caused by lutetium decay were subtracted from observed coincidences caused by hafnium and lutetium decay. There were 80- and 124-kev gamma rays associated with the decay of hafnium-172. These were not in coincidence. Both gamma rays were in coincidence with lutetium x rays, suggesting that there were energy levels at 80 and 124 kev above the ground state in lutetium-172. These observations were confirmed, and energy levels at 88, 113, 153, 341, 413, and 498 kev above the ground state were proposed. The possible existence of energy levels at 256, 285, 468, 512, and 537 kev was discussed. Orbital electron capture to the ground state of lutetium-172 was proposed. Estimates of internal conversion of the more abundant transitions, together with resolved relative gamma-ray abundances, were used to determine percentages of electron capture to each energy level. Log-ft values were in the range of 8 to 11, indicating first- or second-forbidden transitions. Measurements of the gamma spectrum confirmed the 80- and 124-kev transitions, and transitions with energies of 88, 103, 113, 153, 188, 341, and 413 kev were found. Evidence was found for very minor transitions with energies of 468, 498, 512, and 537 kev. Coincidence was found between the 153- and 188-kev gamma rays. Only 75 percent of the 345-kev gamma rays could be attributed to hafnium-175. The remainder was assigned to the 341-kev transition. The 88-, 113-, and 153-kev gamma rays were found in weak coincidence with several minor radiations. The rate of decay of the 124- and 300-kev photopeaks arising from the decay of hafnium-173 was measured for 14 and 8 half-lives, respectively. The half life was found to be 24.19 ± 0.03 hours. (Dissertation Abstr., 22: No. 7, 1962.)

212 STRAHLENCHEMISCHE REAKTIONEN VON NUCLEINSÄURE UND NUCLEINSÄUREKOMPONENTEN. (Radiochemical Reactions of Nucleic Acids and Nucleic Acid Components). Dieter Weinblum. Thesis, Berlin, Technische Universität, 1961. 97p.

The effects of ultraviolet radiation on nucleic acids were investigated. The problem, results, research on bacteria, stereoisomerism, sensitization, and the water addition reaction are discussed. X irradiation of pyrimidines was also studied using bacteria. Methionine was investigated as a radiation protection agent. The structure of adenine-1N-oxide in bacteria desoxyribonucleic acid was determined. (M.C.G)

213 CHEMISCHE DOSIMETRIE VON GAMMA-STRAHLEN UND STRAHLENEMPFINDLICHKEIT VON GECHLORTEN KOHLENWASSERSTOFFEN IN WÄSSRIGER LÖSUNG. (Chemical Dosimetry of Gamma Rays and Radiation Sensitivity of Chlorinated Hydrocarbons in Aqueous Solutions). Peter Tschichold. Thesis, Basel, Universität, 1961. 103p.

A Co^{60} source was used for the determination of the G values (converted molecules per 100 ev of absorbed energy) in Fricke iron sulfate dosimeters. The G value of 16 was used as the foundation for the first determination of the dose constant (that is the radiator output at unit distance) of Ir^{192} by chemical methods. The value of 5.0 for the dose constant calculated from decay data was confirmed. With the help of these data the dose output in the cone of the cobalt gun of the Basel Burgerspital was determined. This determination indicated the original specification of the Fricke dosimeter must be modified for high dose output. Eleven different chlorinated hydrocarbons in water solution were irradiated with a Co gun. It was shown that for sulfur-free compounds, the behavior does not obey the normal laws of chemical electron theory, but this is not true for sulfur-containing compounds. (tr-auth)

214 UEBER DIE REAKTIONEN VON RÜCKSTOSSATONEN MIT GASEN. (Reactions of Back-scattered Atoms with Gases). J. O. Denschlag. Thesis, Mainz, Johannes Gutenberg Universität, 1961. 2p.

The work contains two parts. In the first part back-scattering was applied as a model case for the fission re-

coils investigated in the second part. In the first section the charge of atoms back-scattered from thoron and actinon were investigated. It could be shown that the hypothesis formulated by Briggs is also valid for actinon and that the charge of the A and B bodies of the decay series at the end of their recoil paths is independent of the initial energies. In the second part a study was made to reproduce a formation of volatile lead Pb^{212} compounds by back-scattering. For that reason thoron was permitted to decay in a methane atmosphere so that the hot lead atoms originating over Po have the possibility of reacting with the methane. A detection of volatile lead was not possible. A new electrolytic separation method for medium thick U lead was described. The formation of organic volatile iodine compound by reactions of hot fission recoil atoms with gaseous methane was detected with the help of such a U lead. Some quantitative assertions were indicated, but not proven definitely. (tr-auth)

215 RADIOCHEMICAL CONVERSION OF HYDROCARBONS. Donald S. McArthur, Peter J. Lucchesi, and Robert B. Long (to Esso Research and Engineering Co.). U. S. Patent 3,055,818. Sept. 25, 1962.

The presence of Be in finely divided form greatly accelerates radiochemical reactions and also exerts an appreciable effect on the selectivity of the reactions. The radiochemical conversion of hydrocarbons may be carried out in admixture with emulsified Be compounds, or the Be may be carried on the surface of a hydrocarbon conversion catalyst. This method is applicable to a variety of hydrocarbon feed stocks and conversion reactions. (D.L.C.)

Raw Materials and Feed Materials

216 (HW-SA-2633) PEROXYACETATE SEPARATION OF CERIUM(IV) FROM TRIVALENT RARE EARTHS IN PUREX PROCESS SOLUTIONS. L. F. Lust and H. H. Van Tuyl (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 26, 1962. Contract AT(45-1)-1350. 17p.

Separation of cerium from the other rare earths by oxidation to tetravalent state and precipitation is described. It was found that cerium can be quantitatively precipitated as a cerium(IV) peroxyacetate from a nitrate solution with only 5 to 15% of the trivalent rare earths carrying on the precipitate. The process is accomplished by the addition of a buffered hydrogen peroxide–sodium acetate solution to a rare earth nitrate feed solution. It was established that when in contact with actual Purex solutions, cerium peroxyacetate precipitates decompose much more rapidly than they do in simulated solutions. It was found that the stability of the precipitate could be extended by periodic addition of more hydrogen peroxide or by the use of a larger initial amount. (M.C.G.)

217 (JEN-106-DMa/I-14) TRATAMIENTO DE DISOLUCIONES DE LIXIVIACION DE MINERALES DE URANIO EN PRESENCIA DE FOSFATOS. COMPORTAMIENTO EN LAS ETAPAS DE AJUSTE DE PH, CAMBIO DE ION Y PRECIPITACION DE CONCENTRADOS. (Behaviour of the pH Adjustment, Ion Exchange and Concentrate Precipitation Stages in the Acid Leaching of Uranium Phosphate Ores). J. Estrada Aguilar and A. Uriarte Hueda (Spain. Junta de Energía Nuclear, Madrid). 1962. 29p.

Recovery of U from acid leach solutions of phosphate ore was studied. It was found that predictions can be made concerning solids removal and U recovery in the pH adjustment stage, resin U capacity, eluating agent suitability, ion exchange stage eluation velocity and eluate U concentration, and composition of the precipitate formed in the concentration stage. The results are valid in the concentration range 0.3 to 0.6 g U_3O_8/l. (J.R.D.)

218 THE INFLUENCE OF THE PRECIPITATION CONDITIONS ON THE SEDIMENTATION PROPERTIES OF AMMONIUM URANATES. Andrzej Deptula (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 7: 341-5(1962). (In English)

Conditions for precipitation of an easily filtrable uranium concentrate, obtained from eluates produced in the extraction of uranium from sulfate leach liquors by means of tri-n-octylamine, are investigated. (auth)

219 CHEMICAL PROCESSING OF URANIUM ORES. E. T. Pinkney, W. Lurie, and P. C. N. van Zyl (Anglo-American Corp. of South Africa Ltd., Johannesburg). TRATAMIENTO DE MINERALES DE URANIO. (Treatment of Uranium Minerals). L. G. Jodra and J. M. Josa (Junta de Energia Nuclear, Madrid). Review Series No. 23/24 of "Developments in the Peaceful Applications of Nuclear Energy" of the International Atomic Energy Agency, Vienna. July 1962. 138p. (STI/PUB/15/23/24). $1.00; 21s; NF 4; DM 3.20 (IAEA).

The chemical processing of uranium ores is reviewed with respect to mineralogy, physical concentration of uranium ores, extraction of uranium from its ores, recovery of uranium from leach liquors, and economics of uranium processing. Three typical plants in existence are described and the respective flowsheets given. The economics of three different hypothetical plants are analyzed and the relative economic merits of ion exchange and solvent extraction evaluated. The bibliography contains references up to 1961. (auth)

220 INVESTIGATIONS ON CONCENTRATION OF ORES AND PLACERS OF SOME RARE METALS. I. V. Chipanin. p.104-15 of "Issledovatel'skii po Obogashchen-iyu i Tekhnologiya Poleznyi Iskopayemykh." Moscow, Gosgeoltekhizdat, 1961.

Results of Be, Li, Zr, and In ore concentration were analyzed. It was established by investigations that natural, pure spodumene and beryllium minerals show low flotation ability. Processing of the surface with NaOH solution raised abruptly the flotation properties of spodumene and beryllium, raised slightly the flotation properties of fluorspar, and did not change at all the properties of quartz. An analogous effect on spodumene and beryllium was exerted by calcinated soda. The process consists in the processing of the ore with alkaline agents during refining and agitation, subsequent washing-out of excessive alkali and slurries, and flotation of the washed material with oleic acid. At a high amount of ferruginous quartz in the ore processing with Na_2S yields a fuller depression of quartz. Eudialite ore of the following composition was investigated: ZrO_2, 2 to 2.5%; Nb_2O_5, 0.20 to 0.29%; TiO_2, 1.5%. It was found that loparite concentrate with 8 to 10% Nb_2O_5 can be extracted by concentration of 1 to 2 mm size ore on a table. Selective separation of aegirite, eudialite, and fluorspars is only achieved by flotation of deslimed ore. Eudialite remains in the tails of aegirite flotation and is separated from nepheline and fluorspar by flotation or electromagnetic separation. Investigations were made of the extraction of In from Au-containing ores of one of the deposits. Two methods are recommended. For ores containing 10 to 15 g/t In, in association with ZnS, selective flotation is recommended. For ores with 2 to 3 g/t In it is suggested that selection be conducted until Cu-Pb-Zn product is obtained which is then subjected to chlorination-annealing and lixiviation. To extract In from dust of a melting shop a system is proposed

which includes reduction annealing at 880 to 930°C. To extract rare metals from placers, methods with jigging and with screw separators are used, and also flotation methods for fine-grained sands. A system is described of flotation concentration of ilmenite-rutile-zircon sands with refining of the concentrates by flotation and magnetic separation. (Ref. Zh. Met., No. 3, 1962)

221 CONCENTRATION OF BERYLLIUM ORES. M. A. Eygeles, I. T. Leviush, and I. V. Fuki. p.115-23 of "Issledovatel'skii po Obogashcheniyu i Tekhnologiya Poleznyi Iskopayemykh." Moscow, Gosgeoltekhizdat, 1961.

Some fundamentals are presented on the technological classification of Be-ores according to a series of features characteristic for their concentration technology (the size of disseminations of Be-minerals, the mineralogical shape of Be, the composition of valuable minerals, the substantial composition of the ore mass). The concentration of beryllium ores was developed in two directions: the acid method and the alkaline method. Both these methods are based on the depression of dead rock minerals and the activation of beryllium flotation. An advantage of the acid method is the considerable activation of beryllium by HF and the possibility of obtaining separately mica, quartz, and fluorspar products. A deficiency of this process is the necessity of double flotation of the basic ore mass in a strongly acid medium. In the alkaline method, Na_2S is used as a selectively acting depressor, which makes it possible to depress, in one procedure, the basic dead rock minerals. Beryllium flotation can be intensified by the following means: processing the pulp by the collector during its heating to 80 to 85°C and removing multivalent cations during the softening of water. A method of flotating beryllium ore without preheating the basic pulp mass was developed under laboratory conditions. The basic flotation is carried out at room temperature with oleic acid. Na_2S is used as a depressor. The basic flotation concentrate is processed with Na_2S, heated and refined once or twice. The results of concentration obtained from both acid and alkaline methods are similar. Concentration of micaceous ores is complicated by the introduction of additional fluorite and actinolite cycles of flotation and repeated refining with preheating of the pulp. An additional cycle of talcum flotation is introduced prior to the processing with reagents, to remove easily flotated talcum and talcum rocks. Methods of concentration ability tests are presented. (Ref. Zh. Met., No. 12, 1961)

Separation Processes

222 (AE-82) SOME CHEMICAL GROUP SEPARATIONS OF RADIOACTIVE TRACE ELEMENTS. K. Samsahl (Aktiebolaget Atomenergi, Stockholm). June 1962. 18p.

As a pretreatment for gamma spectrometric analysis methods were developed for the chemical separation of traces of P, Sc, Ge, As, Se, Br, Zr, Nb, Ru, Ag, Cd, Sn, Sb, I, Hf, Ta, Re, Os, Au, and Hg into 9 different groups. By combining the present methods with already existing chemical group separation methods for traces of Na, K, Ca, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Rb, Sr, Mo, In, Fe, Cs, Ba, La, the rare earths, W, and Ir, a complete separation scheme comprising 15 groups of elements has been worked out. The chemical 15-group separation method has been advantageously used in gamma spectrometric routine analysis of biological materials. (auth)

223 (AERE-R-4119) SOLVENT EXTRACTION BEHAVIOUR OF PLUTONIUM CUPFERRATES. I. Pu(III)-CUPFERRATE. D. M. Kemp (United Kingdom Atomic Energy Authority Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). July 1962. 23p.

The solvent extraction of Pu(III) cupferrate into chloroform from 0.15 M perchlorate media and 1.0 M chloride media was investigated. Cupferron is shown to oxidize Pu(III) in acidic solutions, the highest rate of oxidation being at pH values between 1 and 2. This oxidation is not minimized by the presence of reducing agents such as hydroxylamine perchlorate or ammonium sulfite. Pu(III) appears to be eight co-ordinated in the extracted cupferrate, and extraction constants were calculated on this basis. Preliminary results for the solubility product of Pu(III)-cupferrate are reported. (auth)

224 (ARF-1207-6) RESEARCH ON NEW METHODS OF PREPARING HIGH SPECIFIC ACTIVITY RADIOISOTOPES. Quarterly Progress Report No. 2, June 1, 1962 to August, 31, 1962. L. Mamula and P. Y. Feng (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Contract AT(11-1)-578. 12p.

Activities in a program devoted to preparation of high specific activity radioisotopes are reported. Several experiments were conducted during the period which proved the feasibility of a proposed process for the preparation of high specific activity radioisotopes of an element normally possessing only one stable oxidation state. Using Ba as the experimental specie, an enrichment factor of two to three was obtained. Enrichment of various radioisotopes can be achieved by use of aluminum silicate cation fixation process. Experimental results indicate that parameters such as the eluting ion concentration and contact time affect enrichment. It also appears that repeated use of the same clay in a milking process may be feasible, and that higher flux or longer irradiation time should favor a higher enrichment factor. (J.R.D.)

225 (CRCE-1042) CHEMICAL ASPECTS OF THE USE OF SOLUBLE POISONS FOR REACTIVITY CONTROL IN CANDU. I. SOLUBLE POISON REMOVAL BY ION EXCHANGE. R. E. Hollies and H. K. Rae (Atomic Energy of Canada Ltd., Chalk River, Ont.). July 27, 1962. 42p. (AECL-1597)

The removal of boric acid and cadmium sulfate from water by ion exchange resins down to concentrations of 0.01 ppm or less was studied. Because of the much smaller quantity of resin required for cadmium sulfate removal, it is recommended as the soluble poison to be used in CANDU. Ion exchange equilibrium constants were measured and the resin loading in small columns was determined under a variety of operating conditions. Some tests were made of mixed-bed regeneration after loading with cadmium sulfate. (auth)

226 (HW-74609) LOADING AND ELUTION CHARACTERISTICS OF SOME NATURAL AND SYNTHETIC ZEOLITES. L. L. Ames, Jr. and K. C. Knoll (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 10, 1962. Contract AT(45-1)-1350. 38p.

The cation exchange characteristics of several commercially available zeolites were evaluated. Equilibrium loading characteristics and exchange capacities were determined experimentally in the binary systems cesium–lithium, cesium–sodium, cesium–potassium, cesium–rubidium, cesium–hydrogen, cesium–ammonium, strontium–magnesium, strontium–calcium, strontium–barium, and strontium–hydrogen for several zeolites. Exchangeable cation fractions in the equilibrium solutions were varied from 0.2 to 0.00001, while the total normality of the system constituents was held constant. Results were plotted as equivalent fraction of the traced cation on the zeolite at equilibrium vs. the fraction of traced cation

remaining in the equilibrium solution. If an influent composition is known, and falls in the system listed above, zeolite column loading may be read directly in univalent-univalent or divalent-divalent systems. However, in the strontium–sodium or strontium–hydrogen systems, a k value must be used because squared terms appear in the equilibrium expression as follows: 2 Na-zeolite + Sr-solution ⇌ 2 Na-solution + Sr-zeolite, or $k = \frac{(\text{Sr-zeolite})(\text{Na-solution})^2}{(\text{Na-zeolite})^2(\text{Sr-solution})}$. The k for a given cation is a function of zeolite loading with that cation. Several column 50% loading capacities were determined to randomly test the validity of the above curves to predict column capacities. Several columns loaded with known amounts of cesium and strontium radioisotopes were heated to 600°C for 24 hours to simulate a zeolite packaging dehydration cycle. Losses of cesium and strontium activity during the 24-hr period were determined. Elution of the remaining activity on the columns was accomplished with various eluting agents including dilute HNO_3, NH_4NO_3, $CaCl_2$ and $La(NO_3)_3$, and elution curves were calculated. (auth)

227 (IA-736) 1. N-HYDROXYPOLYVINYLPYRIDINIUM TYPE ANION EXCHANGERS. A. Heller, Y. Marcus, and I. Eliezer. 2. URANIUM, PLUTONIUM, BERYLLIUM AND ZIRCONIUM COMPLEXES OF PYRIDINE-N-OXIDE-2-CARBOXYLIC ACID. A. Heller, R. Elson, and Y. Marcus (Israel. Atomic Energy Commission, Rehovoth). Apr. 1962. 11p.

Crosslinked N-hydroxypolyvinylpyridinium ion exchangers were prepared in an attempt to utilize the specificity which N-oxides show toward heavy metals, U in particular. However, the polymers obtained behaved as ordinary anion exchangers, somewhat less basic than Dowex-2. The main advantage of the new exchanger is its high exchange rate. In other work, the pyridine-N-oxide-2-carboxylic acid complexes of U(VI), Pu(IV) and (VI), Be, and Zr were prepared. (J.R.D.)

228 (IDO-14569) PILOT PLANT DEVELOPMENT STUDIES OF A CONTINUOUS PROCESS FOR RECOVERING URANIUM FROM NICHROME FUELS. H. V. Chamberlain (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). June 20, 1962. Contract AT(10-1)-205. 66p.

Pilot plant studies were conducted to develop a continuous process for recovering uranium from nichrome fuels (HTRE). The process consisted of dissolution of fuel in mixed $HCl-HNO_3$ solution, removal of the chloride ion by stripping with HNO_3 in a packed column, and then recovery of the uranium by TBP solvent extraction. Recovery of uranium from nichrome fuels at satisfactory rates and efficiencies can be obtained by this process. Reactor fuels containing large amounts of silica may present a solids problem during chloride removal. Titanium is a suitable material of construction for the dissolver, stripping column, and their associated equipment (feed, off-gas, and product vessels). Stainless steel equipment is suitable for the solvent extraction system. (auth)

229 (IS-377) ION-EXCHANGE METHODS FOR OBTAINING PURE METALS. J. E. Powell and F. H. Spedding (Ames Lab., Ames, Iowa). [1961]. Contract [W-7405-eng-42]. 30p.

Ion exchange was used for separation of rare earth metals in a highly pure form. Two techniques for resolving mixtures are described: ion-exchange elution chromatography and ion-exchange displacement chromatography. (M.C.G.)

230 (IS-420) DEVELOPMENT OF A COUNTERCURRENT, MULTISTAGE, FUSED SALT-MOLTEN METAL EXTRACTOR. Paul Richard Josephson, Jr., and Lawrence Burkhart (Ames Lab., Ames, Iowa). July 1961. Contract W-7405-eng-82. 75p.

A multistage, counter current extractor was developed for use with fused salt-molten metal systems. The most important factors considered in designing the extractor were the ability to create new interfacial areas and to maintain high surface to volume ratios for the dispersed phase. Other considerations were adequate mixing, increased retention time of the metal in the salt phase, ease of assembling, and flexibility of equipment. The extractor, a modified disk and doughnut type, was constructed of type 316 stainless steel. A system of fused KCl-ZnCl eutectic and molten Bi, with Cd as the transferring element, was used to test the equipment. Problems with valve seals, flow meters, and interface measurements were encountered. Methods of pumping the molten materials and of sealing the equipment were also considered. Final extraction runs were made to measure the stage efficiencies of the column. Stage efficiencies of 37% were obtained. The results indicated that the equipment could operate at higher efficiencies. (auth)

231 (JEN-104-DMe/I-10) REDUCCION DEL TETRAFLUORURO DE URANIO EN BOMBA CERRADA. PARTE II: INFLUENCIA DE ELEMENTOS DE ADICIÓN EN LA REDUCCIÓN. (Bomb Reduction of Uranium Tetrafluoride. Part II. Influence of the Addition Elements in the Reduction Process). R. Anca Abati and M. Lopez Rodriquez (Spain. Junta de Energía Nuclear, Madrid). 1962. 24p.

Results of an investigation are presented which show the effects of uranium oxide and uranyl fluoride on the bomb reduction to U using Ca and Mg. Yield-concentration curves show two regions in which the effects of uranyl fluoride are apparent, depending on the salt concentration. The behavior in these regions can be explained by examination of the various decompositions that can take place during the reduction processes. (J.R.D.)

232 (RFP-265) THE USE OF NUCLEAR POISONS FOR CRITICALITY CONTROL IN CHEMICAL PROCESSING. C. L. Schuske (Dow Chemical Co. Rocky Flats Plant, Denver). Mar. 14, 1962. Contract AT(29-1)-1106. 19p.

Nuclear poisons for process plant application may be subdivided into soluble and fixed poisons. The poison does not need to have an absorption cross section of several thousand barns to be effective. The use of carbon tetrachloride or trichloroethylene with a chlorine cross section of 34 barns is a typical example. Some fixed poisons are borosilicate glasses containing 4 to 6% boron as B_2O_3. The glasses can be obtained as Raschig rings of various sizes, tubing, and solid rods. Boron loaded stainless steels are also effective for nuclear poisoning. A series of multiplication measurements made at Rocky Flats on uranium systems containing boron as a nuclear poison is discussed. (auth)

233 (TID-16695) SCINTILLATING ANION EXCHANGE RESIN. Progress Report No. 2. A. H. Heimbuch (Tracerlab, Inc., Richmond, Calif.). Sept. 10, 1962. Contract AT(30-1)-2885. 14p.

In an effort to produce a scintillating anion resin attempts were made to introduce quaternary ammonium groups into the resin made of cross-linked polyvinyltoluene with a minimum loss in pulse height. Studies were made of reaction temperature, time, and solvents as well as different light-wave shifters. Multiple simultaneous experiments were made to obtain valid comparisons of polymerization initiators and suspension stabilizers. (M.C.G.)

234 (EURAEC-298) REPROCESSING IRRADIATED FUELS. Special Report No. 3, November–December 1961. (Trip Report–U.S.A.). (Brussels. Centre d'Etude de l'Energie Nucleaire). Work Performed under United States–Euratom Joint Research and Development Program. Contract 049-61-4-RDB. 11p. A translation.

Reprocessing of fuel by volatilization is discussed. The processes described include: the direct fluorination of UO_2, the dissolution by hydrofluoric acid and nitrogen oxide mixtures (NITROFLUOR process), and fused salt fluorination. Procedures for plutonium reprocessing are also described. The part played by chlorination in reprocessing is discussed. (M.C.G.)

235 EXTRACTION OF LANTHANIDES AND ACTINIDES BY MEANS OF DIBUTYLPHOSPHORIC ACID. [PART] II. G. Duyckaerts and Ph. Dreze (Laboratoire de Chimie Nucleaire, Val-Benoit, Liege). Bull. soc. chim. Belges, 71: 306-23(May-June 1962). (In French)

The mechanism of the extraction by dibutylphosphoric acid of La and trivalent actinides was established by taking into consideration the partition of the complexing agent and its dimerization in organic diluents. The stability constants of the dibutyl phosphates of La and of some trivalent actinides were calculated, and the extraction was discussed as a function of atomic number. (tr-auth)

236 A PROCESS FOR SUMMARY EXTRACTION OF NIOBIUM AND TANTALUM FROM STEEL SOLUTION. P. Muenchow. Chemiker-Ztg., 86: 411-15(June 20, 1962). (In German)

The determination of Nb and Ta in steel and other alloys includes a complete separation of both elements. One of the customary precipitation methods used for steel solutions was previously tested radiochemically and, especially at low concentrations, an incomplete precipitation was ascertained. An extraction process for common separation was developed and investigated radiochemically for completeness of extraction. In the extracted Nb-Ta mixture the impurities extracted with them were detected spectrographically and determined semi-quantitatively. A study of the disturbance of the gravimetric determination of both elements by precipitation with cupferron and the photometric determination with calcium thiocyanate (Nb) and pyrogallol (Ta) by means of these impurities showed that, after the common extraction of both elements, a process for separation of these impurities must be inserted. (tr-auth)

237 THE SIMULTANEOUS EXTRACTION OF URANYL NITRATE AND OF CERIC NITRATE BY TRIBUTYLPHOSPHATE (TBP). A. V. Nikolaev, O. R. D'yachenko, and Yu. A. Afanas'ev (Inorganic Chemistry Inst., Academy of Sciences, Siberian SSR). Dokl. Akad. Nauk SSSR, 146: 102-3(Sept. 1, 1962). (In Russian)

The extraction of uranium and cerium by TBP was investigated in the system: $UO_2(NO_3)_2$–$Ce(NO_3)_4$–1.5 N HNO_3–H_2O–TBP. The distribution coefficients K_U and K_{Ce} fall off with the simultaneous extraction of uranium and cerium with 100% TBP. The value of $K_{Ce} > K_U$ for solutions having an equal amount of both salts. At concentrations of greater than 200 g/l, the distribution coefficients of uranyl nitrate and Ce(IV) are very close to each other. Hence, it is not possible to separate U(VI) and Ce(IV) by counter-current extraction methods. (TTT)

238 COUNTER-CURRENT EXTRACTION IN A LABORATORY MIXER-SETTLER. Vratislav Šraier (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, [Prague]). Jaderna Energie, 8: 274-80(1962). (In Czech.)

A complete extraction apparatus suited for the investigation of the extraction of uranium and of the distribution of concentration in it is described. Uranyl nitrate was extracted and reextracted in a ten-stage laboratory mixer-settler in the conditions of the first cycles of Purex and Redox processes (acid and acid-deficient). The concentration of uranium and nitric acid in the effluents and in individual steps of the mixer-settler was investigated. The extraction of uranyl nitrate with tributylphosphate and methylisobutylketone was good in acid medium, but in acid-deficient medium was not complete. The effluent solutions are in good accordance with the composition of solutions for Purex and Redox processes. (auth)

239 Pu(IV)-EXTRACTION WITH ALIPHATIC KETONES. Libor Kuča. Jaderna Energie, 8: 286-7(1962). (In Czech.)

The extraction capacity of some aliphatic ketones with direct and branched chain for Pu(IV) was investigated. The extraction was carried out using the following compounds: methyl-n-propylketone, methyl-n-butylketone, methyl-isobutylketone, methyl-tert, butylketone, methyl-n-amylketone, methyl-n-hexylketone, ethyl-n-butylketone, and di-n-propylketone, in solutions with starting concentrations 0,3 – 8 N of HNO_3 in the aqueous phase. Factors influencing the extraction efficiency of ketones were of several types. The extraction efficiency of ketones of the same structural type decreases with the increasing length of the chain. The Pu(IV)-extraction with branched chain ketones was worse than with isomeric ketones with direct chain. Methyl-n-alkylketones were the most efficient extractants between isomeric compounds. The extraction efficiency of ketones is discussed from the point of view of steric and inductive influence of the side chain on the oxygen atom of the carbonyl group. The mechanism of the Pu(IV)-extraction with methylisobutylketone was investigated in more detail. Pu(IV) was extracted from 1.5 N HNO_3 into the organic phase mostly in the form of $Pu(NO_3)_4$. The ration of acidocomplexes in the organic phase increased with increasing acidity. The organic phase contained only $H_2Pu(NO_3)_6$ in the extraction from 6 N HNO_3 and the corresponding aqueous phase contained partly dissociated $HPu(NO_3)_5$ and $H_2Pu(NO_3)_6$. (auth)

240 ION-EXCHANGE PURIFICATION AND DBP EXTRACTION OF Ce-144 FROM LACTIC ACID MEDIUM. Ernoe Bruecher. Magy. Tud. Akad. At. Kut. Int. (Debrecen) Kozlemen., 4: 37-43(May 1962). (In Hungarian)

For nuclear spectroscopy purposes a Ce^{144} preparate was purified. On a cation exchange column Sr^{90}/Y^{90}, Eu^{155}, and Pm^{147} impurities were separated from Ce^{144} by a lactic acid elution of 0.4M. A rapid method was developed to recover Ce^{144} from the lactic acid solution. As an extracting agent a 0.1M solution of di-n-butylphosphate dissolved in CCl_4 was employed. The degree of extraction of Ce^{144} from the lactic acid solution of 3.0 ± 0.4 pH was found to be 100 ± 1%. (auth)

241 SORPTION EXTRACTION OF NIOBIUM AND TITANIUM. N. M. Sobinyakova and M. A. Soynova. Mineral'n. Syr'e, Moscow, Sb. 1961, No. 2, 179-92(1961).

The process of sorption separation of Nb and Ti on anionites is described. Nb and Ti sorption on anionites from sulfuric and oxalic acid solutions was investigated. This method was evaluated, for processing non-conditional Nb concentrates obtained from concentration and chlorination. There are 12 references. (Ref. Zh. Met., No. 3, 1962)

242 ÜBER DIE TECHNOLOGISCHE ANREICHERUNG DES BERYLLIUMS UND SEINE AUFBEREITUNG AUS LÖSUNGEN. (Technological Concentration of Beryllium and Its Separation from Solutions). Albert Freiherr von Klein. Thesis, Mainz, Johannes Gutenberg Universität, 1962. 1p.

A review is given of the methods presently used for the concentration of Be from its most important mineral, beryl. After a survey of the analytics of Be, a spectral photometric determination method is given and applied to samples. The pattern of Be concentration during bauxite processing by the Bayer method was followed. The relatively high Be concentration predicted in the literature in calcined alumina does not originate from the alumina dehydrates but probably from the soot particles introduced by the fuel of the furnace. The possibility of concentrating, separating, and purifying Be from fluoride containing solutions of other cations is discussed. (tr-auth)

243 LÖSUNGSMITTELEXTRAKTION VON SPALTPRODUKTEN MIT HILFE VON TRI-n-BUTYLPHOSPHAT UND TRI-n-OCTYLPHOSPHINOXYD. (Solvent Extraction of Fission Products Using Tri-n-butyl Phosphate and Tri-n-Octylphosphine Oxide). Zenab El-Sayed Moustafa. Thesis, Mainz, Johannes Gutenberg-Universität, 1962. 3p.

The extraction of the following fission products using undiluted tri-n-butyl phosphate (TBP) was investigated in dependence on hydrochloric acid concentration: Sb(III), Sb(V), As(V), Cd, Ce, Mo, Nb, Ru, Ag, Tc, Te(IV), Y, Sn(IV), and Zr. The HCl concentration was varied between 1 and 11N. All distribution coefficients were measured by forward and backward extraction. Differences were only observed in Ru and Sb(V), that is, the coefficients were higher in the back extraction than in the forward. In most elements the distribution coefficients increase with increasing HCl concentration, with a maximum occurring between 4 and 5N HCl. The curve track can be relatively flat (Sb(III), As(III), As(V), Cd, Ru, Tc, and Sn(IV)) or be precipitous (Sb(V), Ce, Mo, Nb, Te, Y, and Zr). Silver shows with increasing HCl concentration constantly falling distribution coefficients. Sb(III), Sb(V), As(III), Cd, Mo, Nb, Ag, Tc, Te, Sn(IV), and Zr were extracted almost quantitatively under optimum conditions, whereas As(V) and Ru are distributed almost equally between the two phases, and Ce and Y were extracted significantly only in concentrated HCl. A complete separation of the fission product mixture from HCl is not possible, on the contrary group separations were obtainable. In the range of optimum HCl concentration, extraction with diluted TBP up to 0.1M and 0.03 to 0.3M tri-n-octylphosphinoxide (TOPO) in benzene was investigated. In general the distribution coefficients sharply decreased with increasing dilution excluding Zr and Nb where the dilution is less effective. The distribution coefficients in 0.3M TOPO are generally approximately equal to that in pure TBP; in As(III) and As(V) as well as Cd, they are higher or lower by more than an order of magnitude. Carrier concentrations from 1 to 10 mg/ml do not significantly affect the extraction with TBP. Extraction with TBP and adsorption on ion exchangers show the same dependence on the HCl concentration. It can therefore be concluded that also for TBP extraction anionic metal complexes are prerequisites. The metal complexes react with the onium ion of the solvent $\rightarrow P = OH^+ Cl^-$ in the direction of ion exchange to a neutral extractable ion associate. (tr-auth)

244 BEITRAG ZU EINEM TRENNSCHEMA DER SPALTPRODUKTE MIT IONENAUSTAUSCHERN. (Contribution to a Separation Scheme for Fission Products Using Ion Exchangers). Karl-Erich Seyb. Thesis, Mainz, Johannes Gutenberg Universität, 1961. 2p.

As part of the general analysis for all fission products, a cation exchange method for the rare earths, Cs, and the earth alkali metals Sr and Ba was worked out. Elution research with diluted neutral ammonium-α-oxyisobutyrate solutions gave very indistinct elution curves, whereas under almost equal conditions the use of α-oxyisobutyric acid gave sharp curves. A theoretical investigation on the shape of the elution curves in dependence on the plate theory of Mayer and Tompkins showed that the representation of the curve in probability systems with $\lg(V + 1)$ as a characteristic boundary value gave a straight line. The effect of concentration and pH of the complexing solution on the separation of Y and Tb was investigated under constant conditions. The separation results are good so long as the ratio of undissociated to dissociated complexing agents remains greater than 1:2. The more this ratio fell short, the smaller was the separation factor and the sharper was the deviation of the elution curve from theoretical. The good separation results were explained through the presence of an associate of the form $MX_2(HX)^+$, which is more favorable for the exchange kinetics and the selectivity of ion sizes than the simple MX_2^+ complex. The composition (MX_2^+) of the eluted Y and Tb complexes and their formation constants (2.2 or 2.0×10^6) was determined from the dependence of the relative absorption (Kd/Kd_0) on the concentration of the complexing α-oxisobutyrate anions (X^-). The Kd_0 values were determined from the distribution between Dowex 50, X8 and 0.125 and 1M amonium chloride solutions at 83°C. For the calculation of (X^-), the dissociation constant of α-oxisobutyric acid was measured by two independent methods at 1.77×10^{-4} (83°) and 1.74×10^{-4} (room temperature). The optimum conditions were determined from a study of the effect of flow through velocity, temperature, carrier mass, cross linking, and grain size of the resin. Additional research served for the classification of the elements As, Cs, Sr, and Ba in the separation of the rare earths. Arsenic was not adsorbed on the cation exchange and Cs can be eluted with 1M NH_4Cl before the separation of the rare earths without disturbing this separation. Sr and Ba were separated after the rare earths with HCl at increased concentration; complex elution is not suitable. Zr can also be separated before the rare earths with 1M α-oxisobutyric acid at pH 2.5. The separation method was tested on a fission product mixture. All expected elements could be isolated with high purity and yield. From the absolute calibration of the measurement apparatus with a scintillation counter with a liquid scintillator, the fission yields of the isolated isotopes were determined and the values obtained agree well with values given in the literature. (tr-auth)

245 IMPROVEMENTS IN OR RELATING TO URANIUM RECOVERY PROCESSES. John Molyneux Fletcher, Arthur Gregory Wain, Norman James Keen, and James Louis Woodhead (to United Kingdom Atomic Energy Authority). British Patent 906,618. Sept. 26, 1962.

A process is given for recovering U from a Zr alloy containing from 1 to 50 wt.% U. The process comprises dissolving the alloy in a solution of HF and KF and separating a precipitate of mixed K and U fluorides from the solution. The effects of HF and KF concentrations on the efficiency of U precipitation are shown. (D.L.C.)

246 IMPROVEMENTS IN OR RELATING TO VESSEL INSTRUMENTATION. Adrian Walton Fenton and Stanley Alexander Dean (to United Kingdom Atomic Energy Authority). British Patent 906,719. Sept. 26, 1962.

The separation of uranyl nitrate by solvent extraction in a mixer-settler apparatus usually results in the formation of crud and indefinite phase interfaces. An ultrasonic apparatus is designed for remotely measuring the interface levels and the depths of the contents of a settler compartment of a mixer-settler apparatus. (D.L.C.)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

Refer also to abstracts 16 and 26.

247 (NAA-SR-6490) DEVELOPMENT OF A LARGE METAL ULTRAHIGH VACUUM SIMULATION CHAMBER. F. J. Kamensky (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 1, 1961. Contract AT(11-1)-Gen-8. 41p.

A large ultrahigh vacuum chamber was built for environmental testing of components for the SNAP program at temperatures as high as 1000°F. The chamber employs diffusion, electronic, and cryogenic pumping to handle high gas loads at high temperature and ultrahigh vacuum. A unique internal heating system, connections, assemblies, flanges, and test set-up jigs are described in detail. (auth)

248 (NP-12088) SURFACE BURST OF A 100 TON TNT HEMISPHERICAL CHARGE WIRE DRAG GAUGE MEASUREMENTS. Suffield Technical Note No. 80. John M. Dewey (Canada. Suffield Experimental Station, Ralston, Alberta). June 25, 1962. 16p.

Cantilever wire drag gages were exposed on four radial lines, one in each quadrant, in the 8 psi to 4 psi region. The degree of bending was that predicted for a 200,000 lb TNT ground burst charge and no lack of symmetry of the blast wave was detected. (auth)

249 (NP-12146) ELASTIC RAYLEIGH WAVE DISPLACEMENTS DUE TO NUCLEAR BLASTS. M. L. Baron and R. Check (Mitre Corp., Bedford, Mass.). Sept. 1962. Contract AF33(600)-39852. 38p. (SR-58)

Results are presented for the displacements due to Rayleigh waves which are produced by transient normal surface pressure distributions on a semi-infinite elastic half-space. Expressions for the Rayleigh wave displacements produced by a concentrated load on the surface of the medium are used as influence functions to construct, by means of suitable integrations in space and time, the corresponding quantities produced by the pressure distributions from a nuclear burst. Numerical results are presented at various depths and locations in the medium. A discussion of these results and of the applicability of the theory of actual situations is presented. (auth)

250 (NP-12147) MECHANICAL TESTING TO 6000°F. Progress Report No. 5, February 1, 1962–May 1, 1962. R. F. Brodrick, D. J. Fritch, and B. P. Friesecke (Lessells and Associates, Inc., Boston). June 8, 1962. Contract AF33(616)-7554. 14p.

Activities in a program to develop a testing facility capable of measuring the mechanical properties of materials at 2000 to 6000°F in vacuum are described. Solution of the problem of specimen surface damage by the electron beam is reported. Other work was done to improve the filament life in the machine. Details of preliminary tests on cylindrical W samples are included. (J.R.D.)

251 (NP-12148) MECHANICAL TESTING TO 6000°F. Progress Report No. 6, May 1, 1962–August 1, 1962. R. F. Brodrick, D. J. Fritch, and B. P. Friesecke (Lessells and Associated, Inc., Boston). Sept. 1, 1962. Contract AF33(616)-7554. 12p.

Activities in a program to develop a testing facility capable of measuring the mechanical properties of materials in a vacuum at 2000 to 6000°F are reported. Efforts during the period were directed primarily toward refinement of an electron beam source to obtain greater reliability of components and to minimize specimen surface damage. Data on furnace power are included. (J.R.D.)

252 (ORNL-TM-386) SEALS AND PACKING MATERIALS FOR MOLTEN FLUORIDE SALTS. W. C. Tunnell (Oak Ridge National Lab., Tenn.). [Aug. 29, 1956]. Contract [W-7405-eng-26]. 23p. (CF-55-6-196)

An investigation was made of packing materials, to be used in a conventional type of stuffing box with a rotating shaft, for sealing at elevated temperatures, a fused-salt liquid fuel being circulated by a centrifugal pump. The results of 26 tests are reported in which the fluoride NaF-ZrF_4-UF_4 (50-46-4 mole %) was sealed, with acceptable leakage rates, for periods up to 3500 hr. However, the investigation has not progressed to the point where these materials have been applied successfully to a full-size pump. Various graphites (or graphitic mixtures) were used in the majority of the tests because of their apparent resistance to wetting by the liquid fuel. Of the types of graphite tested, the ones containing large amounts of amorphous C appeared to be the most promising even though they exhibited greater frictional properties. In some tests additives were mixed with the graphite powders as lubricants and/or binders. Although the powdered materials indicate promise as a packing, the main difficulty encountered during the investigation was the retention of the packing itself within the stuffing box. (auth)

253 (TID-16947) VISCOUS SHEAR COMPRESSOR. E. B. Arwas and B. Sternlicht (Mechanical Technology Inc., Latham, N. Y.). Sept. 1962. Contract Nonr-3730(00). 26p. (MTI-62TR21).

A grooved plate viscous shear compressor under polytropic flow conditions is analyzed. Dimensionless curves for calculation of pressure rise as a function of flow are given for isothermal compression, adiabatic compression (monatomic gas), and adiabatic compression (diatomic gas). Sample results are given in graphical form for a specific size compressor operating at 24,000 rpm with four different film thicknesses, ambient pressure, and temperature under isothermal and adiabatic conditions with air and helium. The viscous shear compressor is characterized by its high pressure rise, low flow, and low efficiency. The compressor can generate higher pressures at equal tip speeds than other types. The pressure rise and efficiency are highly dependent on minimum film thickness. As the level of ambient pressure increases so does the efficiency, at the same time peak efficiency shifts to the left on the pressure rise flow characteristic curve. (N.W.R.)

254 (UCRL-6978) A COLD HIGH-VACUUM SEAL WITHOUT GASKETS. Lloyd Mancebo (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 1, 1962. Contract W-7405-eng-48. 13p.

A technique was developed by which the final seal in the vacuum envelope of a device can be made without the use of heat or gaskets. This technique prevents the contamination of sensitive cathode surfaces, oxidation of metal parts near the seal area, and damage to temperature sensitive solid state components. The seal is made between two glass flanges which have been ground optically flat. To effect a seal, the ground flanges are cleaned, placed together, and a vacuum pulled on the envelope. A seal with flanges 4 in. in dia. was made that is still vacuum tight

after 1½ yr. The seal can be baked at any temperature that the components can withstand. The joint is rugged; several test seals were separated only after material was ripped from the mating flanges. The mechanical design is discussed as well as techniques for inspecting for flatness and quality prior to sealing. A method of re-using the same flanges is also presented. (auth)

255 (UCRL-6998) PROJECT YO-YO RADIOCHEMICAL MEASUREMENTS. M. Lindner, K. V. Marsh, J. A. Miskel, and R. J. Nagle (California. Univ., Livermore. Lawrence Radiation Lab.). July 12, 1962. Contract W-7405-eng-48. 53p.

Radioactive Au^{198} and As^{76} were used to study fall-out distributions in small-scale cratering experiments employing 100-gram charges of Comp C-4 high explosive. The division of the radioactivity between crater and fall-out was investigated at varying depths of burial of the charge. The effects of wind and burial depth on the fall-out pattern were determined and compared with one existing theory. An attempt was made to note the effect of differences in volatility of As and Au on the fall-out pattern. (auth)

256 (WAPD-DLE-320) PRELIMINARY REPORT ON DEFLECTION OF TUBE SHEETS. Research Report 100FF996-R6X. M. M. Leven (Westinghouse Electric Corp. Research Labs., Pittsburgh). May 13, 1959. For Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh. Contract NObs-67500. 38p.

The deflections of a perforated epoxy resin tube sheet were studied. In each test the sheet was supported at a 9-in. radius and loaded by a uniformly distributed load applied by lead shot or sand acting over a very thin flexible gasket. In two of the six tests the weight of the sheet alone was used to obtain the desired deflection. A triangular array of perforations was used with a pitch distance between hole centers of 2R = 0.500 inch and hole diameter of 2p = 0.375 inch. Thus the minimum ligament width between perforations is 2h = 2R − 2p = 0.125 inch. The ligament efficiency is h/R or 25%. Deflections calculated using experimentally determined elastic constants give the best agreement with the measured deflections. The theoretically obtained elastic constants of Malkin are in better agreement with those obtained experimentally and are more realistic than those of Horvay. The Salerno modification of the Malkin and Horvay theories is not significant and leads to discontinuities for a certain range of H/R. Measured deflections on tube sheet models and calculated deflections using the Sampson bending elastic constants indicate a maximum stiffness at H/R = 2.25 for the case of h/R = ¼ and v = ½. (auth)

257 (EURAEC-305) WORKING PROCEDURE FOR THE CONSTRUCTION OF PRESSURE VESSELS. Quarterly Report No. 1, January 1–March 31, 1962. H. H. Boesjes, v. d. Blink, Verzijkbergh, and van Veen (Neratoom, N. V., The Hague). Apr. 24, 1962. Work performed under United States–Euratom Joint Research and Development Program. Contract 069-61-12RDN. 10p. A translation.

Steel plates, 200-mm thick, were ordered. The various welding wire and welding power combinations to be used in arc welding under powder were decided on. When making preliminary tests with gas arc welding under CO_2 gas, it was found necessary to adapt the gas nozzle of the welding apparatus to the welding seam shape for thick plates. An existing electrolac welding machine was converted for the encased CO_2 welds. (M.C.G.)

258 (FTD-TT-62-226) EXAMPLES OF THERMOELECTRIC DEVICES (CHAPTER IV). A. F. Ioffe. Translation of p.126-53 (Chapter IV) of "Poluprovodnikovye Termoelementy" (a publication of the Publishing House of Military Literature, Academy of Sciences, USSR, Moscow, 1960). 32p.

Discussions are included on thermoelectric generators, thermoelectric refrigerators, heating and airconditioning, measurement of heat flows and radiant fluxes, aspects of crystallization, and high-temperature thermoelements. (J.R.D.)

259 PRODUCTION OF RADIOISOTOPES IN DENMARK. K. Heydorn (Research Establishment, Riso, Denmark). Ingeniøren, 4: 78-87(Sept. 1960). (In English)

The radioisotope laboratory at Riso is described, and the design of shielded hoods is considered in some detail. The experimental and irradiation facilities of the Danish Reactor DR2 are described. The procedures to be taken in preparing for irradiations are outlined, and irradiations which were carried out are listed. The preparation of carrier-free P^{32} and I^{131}-labeled p-iodobenzenesulfonic acid anhydride is discussed. (D.L.C.)

260 AN ANALOG COMPUTER DEVELOPED CONTROL SYSTEM FOR A UO_3 CALCINER FURNACE. C. E. Huck (General Electric Co., Richland, Wash.). ISA Preprint No. 60.3.62. Pittsburgh Instrument Society of America, 1962. 11p.

A mathematical model was derived for a UO_3 calciner furnace system and made exact using analog computer simulation techniques. Closed loop tests, of the simulated model controlled by a simulated controller, determined the controller mode settings for stability and minimum error during system upsets, and for minimum overshoot at start up. Actual performance of the installed furnace control system was better than predicted by the analog tests. (auth)

261 STANDARDIZATION FOR HIGH PRECISION COAXIAL CONNECTORS. D. E. Fossum (Sandia Corp., Albuquerque, N. Mex.). ISA Preprint No. 53.3.62. Pittsburgh, Instrument Society of America, 1962. 5p.

Microwave measurements made in coaxial systems are frequently limited in accuracy by the connectors themselves. A laboratory connector having negligible error is urgently needed for use in the construction of high-precision components and measurement systems. This connector would enable maximum accuracy in establishing references with the National Bureau of Standards and other laboratories. Standards and measurement systems could then be implemented with considerably better accuracy and confidence. Better accuracy in the measurement of microwave parameters would improve product quality and reduce fabrication costs. (auth)

262 APPARATUS FOR IRRADIATING MATTER WITH HIGH ENERGY ELECTRONS. Alfred J. Gale (to High Voltage Engineering Corp.). U. S. Patent 3,056,024. Sept. 25, 1962.

An electron beam apparatus is provided with means for giving a uniform electron beam at the surface of the substance being irradiated. The means comprises conductive material of non-uniform thickness interposed in the beam path, the thickness being approximately proportional to the electron current density at that point. The material may be superimposed layers of Al foil or a grate. (D.L.C.)

263 VARIABLE INDUCTION MAGNETS OF THE TYPE USED IN SYNCHROTRONS. Jacques Parain (to Commissariat à l'Énergie Atomique). U. S. Patent 3,056,069. Sept. 25, 1962.

A variable induction magnet with an air gap is designed in which the field deformations in the air gap due to mag-

netic saturation under the effect of high induction are corrected. The correction is obtained by means of a zone of low permeability in the pole pieces. (D.L.C.)

Heat Transfer and Fluid Flow

Refer also to abstracts 17, 21, 22, 23, 1054, and 1148.

264 (AE-83) VOID MEASUREMENT BY THE (γ,n) REACTION. S. Zia Rouhani (Aktiebolaget Atomenergi, Stockholm). Sept. 1962. 19p.

It is proposed to use the (γ,n) reaction for the measurement of the integrated void volume fraction in two phase flow of D_2O inside a duct. This method is applicable to different channel geometries, and it is shown to be insensitive to the pattern of void distribution over the cross-sectional area of the channel. The method was tested on mock-ups of voids in a round duct of 6 mm inside diameter. About 40 m.c. Na^{24} was used as a source of gamma-rays. The test results show that the maximum measured error in this arrangement is less than 2.5% (net void) for a range of 2.7 to 44.44% actual void volume fractions. (auth)

265 (APAE-112(Vol.IV)) 30 MEGAWATT HEAT EXCHANGER AND STEAM GENERATOR FOR SODIUM COOLED REACTOR SYSTEM. VOLUME IV. OPERATION AND MAINTENANCE PROCEDURES. (Alco Products, Inc., Schenectady, N. Y.). May 15, 1962. Contract AT(11-1)-666. 65p.

The design, characteristics, shipping and installation procedures, operation procedures, scram and casualty conditions, leak detection, maintenance, water chemistry recommendations, and sodium purity control recommendations for the intermediate heat exchanger and steam generator for 30-Mw sodium cooled reactor systems are described and discussed. (N.W.R.)

266 (CEA-2173) ETUDE D'UN ECHANGEUR NaK–EAU EN REGIMES PERMANENTS ET TRANSITOIRES. (The Study of a NaK–Water Exchanger in Steady and Transient States). D. List and B. Schwab (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). 1962. 40p.

In a study on a NaK–water heat exchanger, the temperature variations, in the transient states, along the metallic wall separating the two fluids were examined. The basic equations (partial differential equations) are established and transformed into a differential equation system for which the various coefficients are calculated. These equations can be set up on an analogic computer for use in exchanger behavior studies. The steady states of the exchanger are studied first and it is then submitted to various types of perturbations. (auth)

267 (EURAEC-313) HEAT TRANSFER AND STABILITY STUDIES IN BOILING WATER REACTORS. Quarterly Progress Report No. 5, January 1, 1962–April 1, 1962. (Eindhoven, Netherlands. Technische Hogeschool). Apr. 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract 032-60-11-RDH. 40p.

Two series of measurements were carried out. In addition to a series already carried out using a stepwise heat flux distribution, experiments were carried out with the same glass shroud with open ends but applying a heating element with a uniform heat flux distribution. Void fraction and circulation rate were measured as a function of pressure up to 30 atm and of power up to 150 kw. Some preliminary results of flow rate versus power for different temperatures are given for the two shapes of heat flux distributions. A comparison of the results shows that there is only a small effect of heat flux distribution on flow rate, except at the lower end of the pressure range. During the experiments some inconsistent values of void fraction were measured. Analysis of these results is under way. In the second series burnout experiments were made using the cluster type of the Halden Boiling Water Reactor elements. These experiments were carried out with a seven rods cluster heating element with aluminum shroud at four temperatures: 140, 180, 200, and 230°C. In order to be able to study the performance of the element under operating conditions as close as possible to those of the reactor, local high heat fluxes were obtained by a "hot patch" produced by thinning locally the walls of the electrically heated tubes. Six burnouts have occurred so far. Four of these can be attributed to high heat flux, two to unstabilities. From the high heat flux burnouts and other results it can be tentatively concluded that the burnout flux increases with quality and decreases with L/D. Also the burnout flux seems to be lower at the outer rods than at the middle one. Comparison with known burnout correlations for other geometries indicated that it is impossible to apply these correlations to the rod bundle geometry. In the instability burnouts large fluctuations in flow rate as high as 50% of the mean values with a frequency of about 0.8 cps were present just before burnout. Some recordings of the flow rate are given. The measuring techniques were further developed, especially in the field of void fraction and pressure measurements. The pressure gauges detecting absolute pressure, boiling noise, and flow rate are working satisfactorily. The scintillation counter for void fraction measurement was constructed. Work on the capacitive void gauge was continued. Some noise signals were recorded and analyzed. A maximum in the power spectral density exists at 23 cps and at low frequencies of about 1 cps. (auth)

268 (IDO-16801) AN OUT-OF-PILE ELECTRON IRRADIATION CIRCULATING LOOP FOR FOULING STUDIES. R. A. Mengelkamp, P. S. Hudson, and J. C. Hillyer (Phillips Petroleum Co. Research and Development Dept., Bartlesville, Okla.). Aug. 1, 1962. Contract AT(10-1)-1080. 10p.

An out-of-pile electron irradiation circulating loop was developed to study the problem of fuel element fouling in organic cooled reactors. Unlike pyrolytic loops and capsules, the irradiation loop operates at temperatures, pressures, fluid dynamics, geometry, and radiation damage which closely resemble reactor conditions. The loop is run in conjunction with the 4-kw – 6-Mev electron linear accelerator. The thickness of the fouling film deposited in the irradiation cell is measured and the film subjected to chemical analysis. Test results showed that clean coolant did not foul; reactor coolant (Core II) with particulate matter fouled; heaviest film was found in the radiation area; and lower fouling occurred at high velocity. (auth)

269 (NAA-SR-Memo-6798) A MODULAR, LOW-COST, SODIUM-HEATED STEAM GENERATOR. (Atomics International. Div. of North American Aviation Inc., Canoga Park, Calif.). Oct. 23, 1961. Contract AT(11-1)-Gen-8. 16p.

A proposed design and development program for a potentially economical, high-performance, sodium-heated steam generator is described. The concept employs modular units grouped together to provide for any combined power level desired. Fabrication expense is shown to be reduced by the reduction in heat transfer area requirements. This reduction is achieved through improved heat transfer coefficients which exist under supercritical steam conditions. The

testing of two small units (~18 Mw total) is shown to be sufficient to verify performance for any size unit because of the modular concept employed. (auth)

270 (NASA-TN-D-1441) COMBINED RADIATION AND FORCED CONVECTION FOR FLOW OF A TRANSPARENT GAS IN A TUBE WITH SINUSOIDAL AXIAL WALL HEAT FLUX DISTRIBUTION. Robert Siegel (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Oct. 1962. 34p.

An analysis is made of the effects that radiation exchanges between elements on the inside surface of a tube have on the wall and gas temperature distributions for forced-convection flow. The wall heat generation has a chopped sine distribution with length along the tube. The flowing gas is assumed transparent to thermal radiation and hence does not participate directly in the radiative exchange process. Axial heat conduction is neglected in the gas and tube wall, and the convective-heat-transfer coefficient is assumed constant. Several numerical examples are given to illustrate the effects of eight independent parameters such as wall emissivity, Stanton number, and length-diameter ratio. (auth)

271 (NP-12161) THREE FLUID HEAT EXCHANGER DESIGN THEORY COUNTER- AND PARALLEL-FLOW (thesis). Technical Report No. 54. Tor Sorlie (Stanford Univ., Calif.). Aug. 1962. Contract Nonr 225(23). 123p.

A design theory for two flow arrangements of three-fluid heat exchangers was developed. The dependent performance of the heat exchanger was expressed in terms of two dimensionless quantities, $\epsilon_{t,c1}$ and $\epsilon_{t,c2}$, termed temperature effectivenesses. The temperature effectivenesses are expressed as functions of five independent dimensionless exchanger variables, three representing operating conditions and two design conditions. This situation contrasts with one dependent and two independent dimensionless parameters for the two-fluid exchanger, a very much less complex problem. Graphs are presented showing $\epsilon_{t,c1}$ and $\epsilon_{t,c2}$ as functions of the five exchanger variables. The practical application of the design theory is shown in three examples. Insight into the problems arising in designing three-fluid heat exchangers can be achieved by inspection of the temperature effectiveness curves. (auth)

272 (TID-16813) BASIC EXPERIMENTAL STUDIES OF BOILING FLUID FLOW AND HEAT TRANSFER AT ELEVATED PRESSURES. Monthly Progress Report, August 1962. Bruce Matzner (Columbia Univ., New York. Engineering Research Labs.). Aug. 31, 1962. Contract AT(30-3)-187. 15p. (MPR-XIII-8-62)

Burnout testing of the internally heated annulus test section was continued and 63 additional burnout points were obtained. The data include runs with outlet subcoolings between 4 and 61°F, pressures of 500, 750, and 1000 psia, and velocities between 5 and 24 ft/sec with no helium addition. Data are presented in tables and graphs. (M.C.G.)

273 (AAEC/Trans-13) FLOW RESISTANCE AND HEAT TRANSFER IN ANNULI WITH ROUGHENED INNER TUBES. H. Brauer (Mannesmann A. G. Forschungsinstitut, Duisburg, Germany). Translated by J. P. Chillag (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). 1961. 22p.

Pressure drop and heat transfer in annular tubes were measured. The surface of the inner tube was artificially roughened. The investigation covered a range of Reynolds numbers from 200 to 100,000. The maximum heat flux, directed from the inner tube to the fluid, was about 316 w/cm^2 or 2.7×10^6 $kcal/m^2$ h. The heat transfer medium was water. The hydraulic diameter of the annular tube served as characteristic length in the dimensionless Reynolds and Nusselt number. The results of all experiments are presented in graphical form. Heat transfer and pressure drop increase with the degree of roughness and depend on the type and arrangement of the roughness elements chosen. (auth)

274 (AEC-tr-5410) THE NATURE OF CONTACT HEAT TRANSFER IN REACTOR FUEL ELEMENTS. V. S. Miller. Translated from Izvest. Vysshikh Ucheb. Zavendenii, Energet., No. 3, 67-70(1962). 9p.

A study of contact heat transfer was carried out at comparatively high heat fluxes (450 to 500 thousand $kcal/m^2$-hr) and at high temperatures between the contact surfaces (350 to 400°C) with various gaseous media. These conditions correspond to the heat transfer conditions between the core and cladding of a fuel element. It was found that increasing the cleanliness of the contact surfaces tends to decrease the thermal resistance. Under otherwise equal conditions, the thermal resistance was high at small compressive forces, where only separate, surface protuberances made contact. The thermal resistance of the junction depended on the contact temperature between the core and cladding of the fuel element. It was found that the principal thermal flux from the hot surface to the cold surface is by thermal conduction through the gaseous medium. (M.C.G.)

275 (EURAEC-294) VIBRATIONS AND LOAD LOSSES IN TUBULAR CLUSTERS. Quarterly Report No. 6, January 1 to March 31, 1962. (Société Grenobloise d'Etude et d'Applications Hydrauliques, Grenoble, France). Apr. 1962. Work performed under United States–Euratom Joint Research and Development Program. Contract 025-60-10RDT. 8p. A translation.

Activities in a program to study the vibrations of a cluster of tubular fuel elements in flow parallel to their axis are reported. Work during the period was devoted to development of flow testing apparatus and assembly of clusters. Preliminary tests were conducted to determine the natural frequency of freely vibrating elements in air and water. (J.R.D.)

276 (EURAEC-303) INVESTIGATION OF BURNOUT IN BOILING WATER. Quarterly Report No. 2, January 1–March 31, 1962. (Maschinenfabrik Augsburg-Nürnberg A. G., Nuremberg). Apr. 16, 1962. Work Performed Under United States–Euratom Joint Research and Development Program. Contract 057-61-RDD. 12p. A Translation.

The basic construction of the high-pressure piping and apparatus for the experiment was concluded. The direct current supply was commissioned. The measurement sections for the round, inside-cooled tubes were constructed. The project for determining the density of wet steam mixtures at the inlet and outlet of the experimental loops by means of gamma ray attenuation was continued. Tests were carried out with various types of thermocouples, in a zero-pressure assembly, in galvanic contact with the current-bearing, heated experimental loops. The results show that in the normal form they are not suitable for measurements of absolute wall temperatures. The first burnout detector on the basis of a bridge circuit was tested on the same experimental assembly. The results were satisfactory. The study of literature and critical analysis of the available data on burnout experiments were continued. (auth)

277 (EURAEC-395) STUDY ON THE VIBRATIONS AND LOSSES OF LOAD IN TUBULAR CLUSTERS. Quarterly Progress Report No. 7, April 1 to June 30, 1962.

(Société Grenobloise d'Etude et d'Applications Hydrauliques, Grenoble, France). July 1962. Work performed under United States–Euratom Joint Research and Development Program. Contract 083-62-1RDF. 7p. A translation.

Efforts devoted to an experimental study of vibrations in a cluster of fuel elements in a flow parallel to its axis are reported. Data from flow tests at velocities of 90, 132, and 156 cm/sec are included. Vibrations at these velocities were perceptible but were too weak for use in establishing a law concerning their relations with velocity. Preparations are being made to conduct tests at higher velocities. (J.R.D.)

278 (EURAEC-404) INVESTIGATION OF BURNOUT IN BOILING WATER. Quarterly Report No. 3, April 1, 1962 to June 30, 1962. (Maschinenfabrik Augsburg-Nurnberg A. G., Nüremberg). June 30, 1962. Work performed under United States–Euratom Joint Research and Development Program. Contract 057-61-RDD. 7p. A translation of MAN-Tka-09-10-62.

The construction of the measurement sections and mock-ups was continued and the current supply planned for the measurement section was tested at 320 atmospheres and 20°C. Preliminary tests were commenced for the trial of a double thermocouple. For the analysis of the available experimental results, a program was drawn up for the IBM 1620 for computing the dimensionless characteristic quantities referred to by Kutateladse and various experimental data were prepared for the calculation. (auth)

279 (FTD-TT-61-395) CONVECTION AND RADIATION HEAT TRANSFER. Translation of "Konvektiviyy i Luchistyy Teploobmen" (a publication of Publishing House of the Academy of Sciences, USSR, Moscow, 1960). 372p.

Separate abstracts were prepared for 5 of a total of 19 included papers. The papers not abstracted are concerned with heat transfer, thermal measurements, thermal radiation, and thermal diffusion. (J.R.D.)

280 (FTD-TT-61-395(p.79-99)) CRITICAL HEAT FLOWS IN THE BOILING OF UNDERHEATED WATER IN CHANNELS OF COMPLEX SHAPE (PRESSURE 100 ATM ABS). I. T. Alad'ev (Alad'yev) and L. D. Dodonov. (Translation).

Results obtained in an experimental determination of the critical heat flows through channels of complex shape are presented. The channels investigated include a VVER model, an annular model, and a VVER model containing tightly packed rods. (J.R.D.)

281 (FTD-TT-61-395(p.100-20)) EXPERIMENTAL DATA ON HEAT TRANSFER IN THE CASE OF NUCLEATE BOILING OF UNDERHEATED WATER IN TUBES. I. T. Alad'ev (Alad'yev), L. D. Dodonov, and V. S. Udalov. (Translation).

Investigations to obtain reliable data on heat transfer in tubes are described. The heating surfaces were kept clean and the water used in the tests was maintained in a degassed condition. Particular attention was paid to measurements of surface temperatures. Results are presented for nucleate boiling at 1 to 181 atm. abs. (J.R.D.)

282 (FTD-TT-61-395(p.121-34)) GENERALIZATION OF EXPERIMENTAL DATA ON THE VISCOSITY AND THERMAL CONDUCTIVITY OF LIQUID METALS. A. G. Usmanov. (Translation).

A generalization of the experimental data on heat transfer from liquid metals through walls and transfer processes in gas phases is discussed. Data are included concerning generalization of results obtained with a metallic group which includes Na and K, and another group which includes Sn, Pb, Bi, and Hg. (J.R.D.)

283 (FTD-TT-61-395(p.246-64)) THERMAL MODELING OF ATOMIC REACTOR FUEL ELEMENTS. V. A. Baum. (Translation).

Results of a study concerning the distribution of temperature in cylindrical reactor fuel elements are presented. It was found that the temperature distribution in the element and the absolute temperature values are strong functions of the contact between the shell and the material enclosed within the shell. (J.R.D.)

284 (FTD-TT-61-395(p.328-67)) HEAT TRANSFER IN THE CASE OF NUCLEATE BOILING. I. T. Alad'ev (Alad'yev). (Translation).

The general quantitative relations governing heat transfer in the case of nucleate boiling are examined. The investigation was conducted by a simultaneous analysis of the data on the mechanism of boiling and heat transfer. Results are compared with the data obtained by other investigators. (J.R.D.)

285 HEAT TRANSFER TO BOILING WATER. Review No. 212. J. K. Wilkinson. Brit. Coal Util. Res. Assoc., Monthly Bull., 26: 109-28(Apr.-May 1962).

The factors influencing ebullition are reviewed. Nucleate boiling, burnout, transition regime, and stable film boiling are considered. Three possible mechanisms are suggested for the triggering of film boiling in industrial boilers. It is shown that the heating surface is the most important factor in boiling. It is concluded that nucleate boiling, which is the most important type of boiling, is still imperfectly understood and its correlations must continue to be empirical or semi-empirical. Equations for estimating heat transfer coefficients are reviewed. (D.L.C.)

286 EFFECTS OF A CHANGE IN WALL ROUGHNESS ON FULLY DEVELOPED FLOW IN A CIRCULAR PIPE. Earl Logan, Jr. Thesis, Lafayette, Ind., Purdue Univ., 1961. 72p.

The flow characteristics in the transition region between fully developed smooth-pipe flow and fully developed rough-pipe flow are studied. An attempt is made to predict the intermediate velocities from relations for fully developed flow, as well as to construct a flow model from the data. Velocity profiles are measured at the exit of a 20-foot-long, 8-inch-diameter smooth pipe, and at ten stations in an adjoining 10-foot-long, 8-inch-diameter sand-roughened pipe. Turbulence velocities and Reynolds' stresses are measured throughout the same region. All measurements are made in air at a Reynolds number of 400,000. Measurements indicate that the wall shear stress is uniform throughout the transition region. The velocity profiles are transformed first by the radial convection of fluid by the mean flow and then by the increased Reynolds' stresses resulting from increased turbulence production. Increases in turbulence intensity are always preceded by increases in velocity gradient. The transport of turbulence energy by convection and diffusion has a negligible influence on the rise of turbulence intensity except near the centerline of the pipe. Turbulence intensities in the wall region of the rough pipe are approximately twice those that occur in the smooth pipe. (Dissertation Abstr., 22: No. 7, 1962.)

287 FORCED CONVECTION FILM BOILING INSIDE OF VERTICAL PIPES. Sidney Rankin. Thesis, Newark, Del., Univ. of Delaware, 1961. 169p.

An experimental and theoretical investigation was carried out of forced-convection film-boiling inside a vertical 4-ft length of 1.06-in.-I.D. steam-jacketed pipe. Peak nucleate

and stable film-boiling data were obtained for both Freon-113 and methanol, for entering velocities ranging from 1.5 to 8.5 ft/sec, at essentially saturated atmospheric conditions. The vapor film was found to be in turbulent motion under these conditions. Heat transfer equations were derived for both laminar and turbulent vapor films. The data were fit by a modification of the laminar theory. The theoretical investigation involved a study of the mechanism of film boiling. The degree of stability of the vapor film was examined, and a mathematical derivation was presented to show that a suitably defined "vapor repulsion force" was sufficient to provide a stable interface under any velocity condition. This result was tested with the data. (Dissertation Abstr., 22: No. 7, 1962.)

288 HEAT AND MOMENTUM TRANSFER IN LIQUID METALS. Edgar Hankins Buyco. Thesis, Lafayette, Ind., Purdue Univ., 1961. 168p.

An experimental and theoretical investigation of the diffusivity ratio for liquid metals was undertaken. Temperature profiles and heat transfer coefficients were measured in a 0.0772-foot-I. D. tube through which mercury was circulated. The diffusivity ratios, Nusselt number, and temperature profiles were measured. Based on a modified Prandtl mixing-length hypothesis, an analytical equation for the diffusivity ratio, alpha, for low Prandtl number was derived. Alpha is expressed as a function of Reynolds' number, distance from the wall, and velocity distribution. For liquid metals, a relation is given for finding the diffusivity ratio. (Dissertation Abstr., 22: No. 7, 1962.)

289 STEAM-COOLED EXPERIMENTAL LOOPS IN NRX. PART I. A SUPERHEATED-STEAM-COOLED EXPERIMENTAL FACILITY IN NRX. N. R. Geary (Atomic Energy of Canada Ltd., Chalk River, Ont.). PART II. CONVERSION TO FOG COOLING. J. C. Horsman (Atomic Energy of Canada Ltd., Chalk River, Ont.). Preprint. [Ottawa], Canadian Nuclear Association, 1962. 13p.

Direct steam cycles are of interest for improving the efficiency of D_2O-moderated power reactors. A joint AECL/UKAEA program is investigating two of the reactor coolants that could be used. A superheated-steam-cooled experimental facility in NRX and the conversion of this equipment to fog (wet steam) cooling are described. (auth)

290 IMPROVEMENTS IN OR RELATING TO VALVED DUCTING. Donald Garden Taylor (to United Kingdom Atomic Energy Authority). British Patent 906,667. Sept. 26, 1962.

A valved ducting is designed for conducting carbon dioxide gas between a reactor and a heat exchanger. The ducting comprises an outer pipe and an inner pipe, and the inner pipe is divided into two parts with separate valves and arranged so that the outer annulus on one side of the division communicates with the inner pipe on the other side and vice versa. Thus, the problem of providing a valve for fluid flow control in the annulus is solved. (D.L.C.)

Materials Testing

Refer also to abstracts 24 and 25.

291 (EURAEC-308) THE DEVELOPMENT OF A NEW DETERMINATION OF THE DUCTILE-BRITTLE TRANSITION TEMPERATURE. Quarterly Report No. M-62-467-26150, January 1, 1962–March 31, 1962. H. C. van Elst (Netherlands. Nijverheidsorganisatie, TNO, The Hague). Work Performed Under United States–Euratom Joint Research and Development Program. Contract 068-61-11-RDN. 46p.

Efforts devoted to development of a brittle-fracture test method for small samples of metal are described. A determination of the velocity of crack propagation was performed in which speed values of 0.83 to 1.62 mm/sec for crack propagation were found by the Robertson Test. Preparation for tests to determine shock waves in metals produced by explosive and electric energy is in progress. Preliminary results on shock wave transmission through steel bars from explosive charges are discussed. (J.R.D.)

292 (HW-74643) X-RAY DETERMINATION OF SURFACE STRESSES NEAR WELDS IN MILD STEEL PIPES. D. R. Green and M. C. Lambert (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 1962. Contract AT(45-1)-1350. 21p.

Quantitative x-ray diffraction stress measurement methods were briefly investigated for applicability to determining whether or not welds in steel pipes were stress relieved. A simple x-ray method for determining the maximum temperature reached during heat treatment was developed. (auth)

293 (RFP-285) DURABILITY TESTS ON PYREX RASCHIG RINGS. C. L. Schuske and H. W. King (Dow Chemical Co. Rocky Flats Plants, Denver). Oct. 26, 1962. Contract AT(29-1)-1106. 8p.

A drop test for individual pyrex Raschig rings was used to determine the durability of these rings. The test rings contained various controlled surface defects and were subjected to various heat treatment cycles. The results show that tempering increases resistance to surface scratches, chemical etching, and fragileness. (auth)

294 THE BETATRON AND ITS UTILIZATION IN MATERIALS TESTING. K. W. Kanngiesser (Brown, Boveri and Cie. A. G., Mannheim, Ger.). Elektron. Rundschau, [14]: 226-9(1960). (In German)

In a betatron electrons are accelerated by an electric field which is surrounded by another magnetic flux and forced by means of a magnetic guide field into a circular orbit. During each acceleration period of 5 msec duration, the electrons rotate approximately 10^6 times around the betatron core before they obtain final energy. If the electrons collide with an anticathode, bremsstrahlung is produced. This radiation is suitable for nondestructive material testing; up to 500 mm of steel can be penetrated. Because of the extremely small focus, excellent fault detection is obtainable. (tr-auth)

295 OBSERVATION AND MEASUREMENT OF BEHAVIOR OF POROUS MATERIALS WHEN RAPIDLY COMPRESSED. R. H. Stresau and H. S. Napadensky (Illinois Inst. of Tech., Chicago). Proc. Soc. Exptl. Stress Anal., 19: No. 1, 15-22(Jan. 1962).

The apparatus and techniques used for the study of the behavior of porous materials when impulsively loaded are described. Observations are made of the displacement-time history of steel plates, which have been accelerated by means of explosives, as they are retarded by specimens of wood and other porous materials. Preliminary dynamic stress-strain data and some observations of compression wave propagation in porous media are presented. (auth)

296 IMPROVEMENTS IN APPRATUS FOR PHOTOGRAPHING NUCLEAR FUEL ELEMENTS. David Llewelyn Ellis (to H. M. Hobson Ltd.). British Patent 906,932. Sept. 26, 1962.

An apparatus is designed for taking x-ray photographs of radioactive fuel elements to reveal any defects or voids between the fuel and its container. The apparatus comprises a protective enclosure, an x-ray head, means for supporting

the fuel element in the enclosure in position to be photographed, a drum for supporting a photographic film and having a shielding core, and means for rotating the drum from a shielding position to an exposure position and back again. (D.L.C.)

297 IMPROVEMENTS IN OR RELATING TO ULTRASONIC TESTING OF MATERIALS. Harry Jackson (to United Kingdom Atomic Energy Authority). British Patent 907,012. Sept. 26, 1962.

An immersion method of ultrasonic testing of materials is outlined which eliminates interference from gas bubbles. In this method, a nozzle pumps some of the liquid to set up a flow across the surface of the test material to sweep out bubbles. (D.L.C.)

GEOLOGY, MINERALOGY, AND METEOROLOGY

298 (AERE-R-3197) PORTABLE EQUIPMENT FOR THE RADIOMETRIC-SURVEY OF BOREHOLES. D. Williams and H. A. Cole (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Aug. 1962. 65p.

Fundamental aspects of borehole γ-logging are discussed, leading to the basic requirements for instrument design. Details are given of the equipments designed at A.E.R.E. during the period 1949 to 1957. (auth)

299 (TID-16781) GEOLOGIC ASPECTS OF THORIUM RECOVERY FROM COMMON ROCKS. Quarterly Progress Report, June 1, 1962 through August 31, 1962. John A. S. Adams and John J. W. Rogers (Rice Univ., Houston, Tex.). For Oak Ridge National Lab., Tenn. Contract [W-7405-eng-26], Subcontract 1491. 25p.

Work was carried out to establish a reasonable estimate of the quantity of thorium available in the Conway granite of New Hampshire. Three cores of 500- or 600-foot length were obtained at different locations within the granite, and the thorium content of these cores was measured. Additional measurements were made at surface stations with a portable gamma spectrometer. From data now available, the indicated tonnage of thorium in the main central batholith of the Conway granite (the White Mountains) is at least 21×10^6 tons. (auth)

300 QUANTITATIVE INTERPRETATION OF THE STATICAL ANOMALIES OF THE GAMMA-RAY LOGS. Jan A. Czubek (Inst. of Nuclear Research, Polish Academy of Sciences, Krakow). Nukleonika, 7: 347-56(1962). (In English)

Static curves of gamma-ray well logs are interpreted theoretically. Nomograms are given for interpretation of the thicknesses of thin layers, and of the true gamma intensities in such layers, for all conventional measuring geometries. (auth)

301 BEHAVIOR OF SHOCK WAVES AT REMOTE DISTANCES FROM THE EXPLOSION POINT. D. E. Okhotsimskii and Z. P. Vlasova. Zh. Vychislitel. Mat. i Mat. Fiz., 2: 107-24(1962). (In Russian)

The behavior of spherical shock waves at remote distances from an explosion center was calculated considering the distribution of hydrodynamic parameters corresponding to a shock pressure drop of 1.1097. The calculations are concerned only with perturbations directly behind the shock front, the remaining gas region is considered to be at rest. Corrections for pressure, density, and particle velocity and calculations of shock front coordinates reduced the calculations to a front pressure of 1.0018. S. A. Khristranovich's approximation method was used for determining distributions at expanded time magnitudes. The results show the appearance of secondary shock waves in the negative phase region. (R.V.J.)

302 PRIMENENIE RADIOAKTIVNYKH IZOTOPOV V GIDROTEKHNICHESKOM STROITEL'STVE. (Applications of Radioisotopes in Hydrotechnology). M. P. Belikov, V. A. Emil'yanov, and V. E. Nesterov. Moscow, State Publishing House of Literature on Construction, Architecture, and Construction Materials, 1961. 164p.

General data on radioisotopes and neutron emissions are covered in the first chapter. The second chapter deals with the particle recording and detectors, especially battery-powered devices suitable for field operations. Uses of gamma radiation for determining the density, humidity, and water clarity are described in the third chapter. Neutron interactions with substances, neutron sources, neutron applications for measuring the humidity, and special field devices are described in the fourth chapter. The fifth chapter deals with tracer methods for measuring the flow rate and volume of underground streams, leaking in closed pipes, and shifts in sand deposits. In conclusion, a short review of safety measures in handling radioisotopes is given. 55 references are included. (R.V.J.)

303 USE OF TRITIUM TO TRACE UNDERGROUND WATER. C. M. Lapointe (Dept. of Mines and Technical Surveys, Ottawa). Preprint. [Ottawa], Canadian Nuclear Association, 1962. 25p.

For tracer work on water, tritium offers advantages of reasonable half life, moderate price, high maximum permissible concentration in water and air, and small chance of selective adsorption on minerals. One disadvantage is that measurement is difficult because of the very low energies of the β radiation. When high dilution of tagged water occurs, enrichment of the samples for counting is required. Enrichment may be accomplished by electrolysis of an alkaline solution of the tritiated water using a Ni anode and a stainless steel cathode. The tritium can be measured by a liquid scintillation counting method in which ethanol is used as a mutual solvent to incorporate the tritiated water into the scintillating solution. As a practical application of this method, attempts to trace the origin of water seepage in certain parts of the underground workings of the Errington Mines of Steep Rock Iron Mines Ltd., Antikokan, Ont. are described. (A.G.W.)

304 THE SITE PLAN FOR THE WHITESHELL NUCLEAR RESEARCH ESTABLISHMENT. F. W. Gilbert (Atomic Energy of Canada Ltd., Chalk River, Ont.). Preprint. [Ottawa], Canadian Nuclear Association, 1962. 5p.

In addition to research facilities, a complete village with normal community services and facilities is being built at Whiteshell Nuclear Research Establishment. The site plan is described, major problems are outlined, and a general construction schedule is presented. (A.G.W.)

305 YADERNAYA GEOFIZIKA. (SBORNIK STATEI PO ISPOL'ZOVANIYU RADIOAKTIVNYKH IZLUCHENII I IZOTOPOV V GEOLOGII NEFTI). (Nuclear Geophysics. (Symposium of Articles on Using Radioactivity and Isotopes in Oil Geology)). F. A. Alekseeva, ed. Moscow, Gostoptekhizdat, 1959. 372p.

Descriptions of neutron and γ-ray recording devices and results obtained using various rocks and drill hole models are included. Neutron applications in determining porosity and the water-oil contact in a seam are analyzed. Applications of tritium isotopes in tracing water and oil seepage are discussed. (R.V.J.)

HEALTH AND SAFETY

Refer also to abstract 20.

306 (CEA-2165) CONCEPTION ET MISE EN OEUVRE D'UNE MACHINE A TRIER LE LINGE EN FONCTION DE SA CONTAMINATION PAR DES PRODUITS RADIOACTIFS. (Development of a Machine for Sorting Laundry According to its Radioactive Contamination). G. Cohendy, M. Alles, and A. Pellerin (France. Commissariat à l'Énergie Atomique. Centre de Production de Plutonium de Marcoule, Chuscian). 1962. 15p.

At the Marcoule Plutonium Production Center special clothing is worn in the active zones. A large fraction of these clothes is contaminated and must be subjected to specialized treatments during washing in order to be reworn without danger. Because of the large amount of clothes to be treated, it became necessary to install a special semi-automatic washing machine; the role of the operator is limited to placing the clothing in the machine and to removing the baskets of sorted clothes. The machine was designed to be used with a sorting method which is based on β radiation and in which Geiger counters actuate an appropriate electronic system depending on the various degrees of contamination of the treated clothing. (auth)

307 (JUL-55-ST) UMWELTRADIOAKTIVITÄT DER KERNFORSCHUNGSANLAGE JULICH. JAHRESBERICHT 1961. (Environmental Radioactivity of the Nuclear Research Institute at Julich. Annual Report 1961). K. J. Vogt (Kernforschungsanlage, Jülich, Germany). Apr. 1962. 87p.

Results of measurements of the environmental radioactivity at the Julich Nuclear Research Institute in 1961 are presented in graphs and tables. The measurement program is described. Control of radioactivity in air included measurements and control of radiation in the atmosphere, aerosol activity, and the total activity of precipitation and meteorological observations. Control in water consisted of monitoring of the activity of ground, surface, and drinking water and monitoring the activity of mud and biological objects in the surface water. The radioactivity of soils, plants, and agricultural products was also determined. (M.C.G.)

308 (NYO-9772) A STUDY OF THE POSSIBLE CONSEQUENCES AND COSTS OF ACCIDENTS IN THE TRANSPORTATION OF HIGH LEVEL RADIOACTIVE MATERIALS. J. M. Morgan, Jr., J. W. Knapp, and J. T. Thompson (Johns Hopkins Univ., Baltimore). Aug. 1961. Contract AT(30-1)-1477. 116p.

Evaluations are made of the possible consequences of accidental releases of high-level radioactive materials during shipment. Truck accident situations are visualized, unit costs for remedial operations cited, and losses established. Items pertinent to cost analysis such as transportation practices, shipping containers, ability of large metropolitan areas to handle accident situations, characteristics of the high-level wastes, fate of radioactive materials in the environment, removal of radioactive nuclides by water treatment facilities, and decontamination procedures are reviewed. (auth)

309 PRESENT PROBLEMS OF RADIATION PROTECTION. Erich Oberhausen. Atom u. Strom, 8: 49-52 (July 1962). (In German)

The principal difficulties in problems of radiation protection are reviewed. Many of the problems originate because of the low maximum permissible levels of dangerous isotopes. Typical whole-body counters are described and typical measurement curves are given. The natural radiation effects on man are shown in tabular form. (J.S.R.)

310 RADIOACTIVE FISSION PRODUCTS AND ANIMAL FOODSTUFF. Bertil Åberg. Kgl. Skogs- och Lantbruksakad. Tidskr., 101: Nos. 1-2, 119-24(1962). (In Swedish)

The three most dangerous radioactive fission products are iodine, strontium, and cesium. Physical data for isotopes of these elements are tabulated. Then physiological properties of these elements which make them of concern are reviewed, and the quantities found in various parts of the body are discussed. (J.S.R.)

311 HYGIENIC AND MEDICAL PROBLEMS IN THE INDUSTRIAL APPLICATION OF NUCLEAR ENERGY IN ENGLAND. L. Rausch (Universität Marburg, Ger.). Med. Klin. (Munich), 55: 45-53(1960). (In German)

A review is given of the health and medical problems occurring in Great Britain as a result of the industrial application of nuclear energy. The radiation sources in a reactor are considered to determine the dangers of each. The factors affecting the site selection for reactors and nuclear energy plants are discussed, followed by a consideration of the safe disposal and processing of radioactive wastes. In conclusion the safety precautions to be followed in the preparation of fuel elements are given. (J.S.R.)

312 RADIATION DANGERS AND RADIATION PROTECTION IN HOSPITALS. W. Pfeifer (Roentgen- und Radium-Abteilung des Oldenburgischen Landeskrankenhauses Sanderbusch, Ger.). Med. Klin. (Munich), [55]: 53-9(1960). (In German)

The origins of natural and artificial radiation are tabulated and their significance in hospitals is indicated. To guarantee the necessary radiation protection and to reduce the radiation burden in the hospital, ten points must be considered. These points are tabulated, and then each is discussed in detail. (J.S.R.)

313 NEW OR LESS WELL KNOWN PRINCIPLES OF THE PRACTICAL EXECUTION OF RADIATION PROTECTION IN THE X-RAY DIAGNOSIS REALM. F. Ekert (Strahlenabteilung des Städtischen Krankenhauses, Munich). Med. Klin. (Munich), [55]: 59-68(1960). (In German)

Radiation protection for hospital personnel, patients, gonads, and growing embryo is described on the basis of experimental results. Supplements to this protection and its limits were indicated. (J.S.R.)

314 RADIATION INJURY IN X-RAY THERAPY. G. Fuchs (Zentral-Röntgen-Institut des Kaiser-Franz-Josef-Spitales, Vienna). Med. Klin. (Munich), 55: 1813-18 (1960). (In German)

A review is made of the injuries occurring after x-ray therapy, with special consideration of late injury. Means and methods for avoiding injury in therapeutic x-ray treatment were also discussed. Some methods of x-ray therapy, as, for example, radiocastration, have the purpose of deliberate damage to an organ and can be carried out without damage to the total organism. X-ray therapy, under professional conditions and precise site location, can be performed without damage to the genetic structure. (tr-auth)

315 THE RADIATION DOSE FROM INHALATION OF RADIUM-EMANATION. Egon Pohl (Universität, Innsbruck and Forschungsinstitut Gastein der Osterreichischen Akademie der Wissenschaften, Badgastein, Ger.). Strahlentherapie, 119: 77-96(Sept. 1962). (In German)

The radiation exposure during the inhalation of air containing radon depends not only on the concentration of the emanation, but also on their content of solid decay products of the radon. A method for the determination of the content of the decay products of the air and the values (for radon) used for the calculation are reported. Moreover the additional radiation exposure received by the lung tissue and the blood from the decay products which are inhaled and filtered by the lung has been calculated. The calculated values for the radon inhalation therapy in the thermal gallery of Badgastein/Böckstein (Austria) are given as numerical examples. It has been shown that the radiation hazards of the patients are negligible in any case. (auth)

316 DECONTAMINATION OF RADIOACTIVE EFFLUENT AIR. Hans Joachim Ochs. Wasser, Luft Betrieb, No. 9, 242-5(1960). (In German)

Decontamination of effluent air is much more difficult than decontamination of radioactive water and soil. The radiation intensity can be easily determined and therefore the difficulty is one of filter techniques and of measurement in standard units of all radioactive substances present with respect to their toxicity and maximum permissible concentration. The filtration of radioactive effluent air and the possibilities and conditions for solving problems of filtration are described. (J.S.R.)

317 RADIATSIONNAYA I KHIMICHESKAYA RAZVEDKA. (Radiation and Chemical Reconnaissance). A. L. Revel'skii. Moscow, Military Publishing House of the Ministry of Defense, 1962. 114p.

A short review is given on chemical and radiation reconnaissance and methods of monitoring radioactivity and poisonous substances. Descriptions are given of devices used for radiation monitoring and of protective measures for personnel handling the equipment. Features of radiation and chemical reconnaissance under combat conditions are discussed. The book is designed for commanding military personnel. (R.V.J.)

318 THE RADIATION PROTECTION PROGRAMME, ONTARIO HYDRO. R. Bruce Trewin (The Hydro-Electric Power Commission of Ontario, Toronto). Preprint. [Ottawa], Canadian Nuclear Association, 1962. 11p.

The radiation protection program for the NPD reactor is based on careful selection of personnel, special training of workmen, and a set of radiation protection regulations. General headings covered in the 75-lecture training course are listed. A table of contents of the radiation protection regulations is included. (A.G.W.)

319 CONSIDERATION OF SAFETY IN THE LICENSING OF NUCLEAR REACTORS IN CANADA. George C. Laurence (Atomic Energy Control Board, Ottawa). Preprint. [Ottawa], Canadian Nuclear Association, 1962. 4p.

One of the responsibilities of the Atomic Energy Control Board is safety in the operation of nuclear reactors. License for operation is not granted unless the Board is satisfied that the reactor can be, and is likely to be, operated with adequate safety. The Board is assisted by the advice of its advisors including its Advisory Committee on Reactor Safety and cooperates closely with federal and provincial departments and minicipal authorities having interest in health and safety where the reactors are located. The paper describes the steps in investigating the safety of the reactor and the procedure leading to the granting of the operating license. (auth)

320 PROBABILITY OF FALLOUT DEBRIS DEPOSITION. Civil Defense Technical Bulletin. A Digest of Technical Information. TB-11-31. (Office of Civil and Defense Mobilization, Battle Creek, Mich.). June 1957. Reprinted April 1961. 48p.

Charts are presented that show the probability of fallout during the first 12 hr following the detonation of a nuclear weapon at various distances and directions from the point of detonation. The charts are based on a U. S. Weather Bureau survey of wind soundings at 41 weather stations in the U. S. over a 5-yr period. The fallout probability pattern is shown with the weather station as ground zero, but the pattern can be applied to any assumed target within the area. The charts were developed for use in conjunction with other significant factors such as probable extent of blast and thermal effects of a nuclear detonation, in making decisions concerning civilian defense. (C.H.)

321 GRAZHDANSKAYA OBORONA. (Civilian Defense). P. T. Egorov, I. A. Shlyakhov, T. V. Dolbnin, and V. S. Mordvinov. Moscow, Vysshaya Shkola, 1962. 364p.

Civilian defense against aerial nuclear attack is discussed. Reconnaissance of contaminated areas, safety and emergency methods, degassification, decontamination, and disinfection as well as medical aid are discussed. (R.V.J.)

322 RADIOACTIEVE BESMETTING VAN DE BIOSFEER IN NEDERLAND. (Radioactive Contamination of the Biosphere in the Netherlands). Johannes Blok. Thesis, Amsterdam, Universiteit, [1957]. 180p.

A study on the radioactive contamination of the biosphere is presented. In the first section the radiation dose from natural radioactivity is considered. Measurements of artificial activity in the air and rain water, carried out during 1955 and 1956, are discussed. The possible hazards to public health of the increased dose level are summarized. The methods used for continuous determination of fission products in air and rain water are reported. Investigations on the properties of the radioactive dust in the atmosphere are indicated. The corrections for geometry and for absorption of beta particles in the sample and the window of the counter are determined. In conclusion, the results of measurements of airborne and deposited radioactive dust are given. (J.S.R.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

323 (TID-6613(Suppl.3)) RADIOISOTOPES IN WORLD INDUSTRY. Abstracts of Selected Foreign Literature. (Division of Isotopes Development, AEC). Oct. 1962. 134p.

An annotated bibliography containing 569 references from foreign literature on the uses of radioisotopes in the physical and engineering sciences is presented. The abstracts are grouped by subject and subgrouped by country to facilitate reference. Author and country indexes are also included. Each abstract also has an index number. (N.W.R.)

324 (OTS-60-51035) THE DETERMINATION OF THE BULK DENSITY OF PRESSED WOOD BY METHOD OF TRACER ATOMS. P. N. Zhitkov. Translated from Derevoobrabatyvayushchaya Prom., 7: No. 3, 16-17(1959). 4p. (PST-Cat-320)

The use of tracers in determining the bulk density of pressed wood is duscussed. Pine, birch, and aspen wood was pressed. Specimens of raw and pressed wood were soaked to saturation in a solution of P^{32} in transformer oil. The specimens were then placed on glass and counted with a Geiger-Mueller Counter. The bulk density of the raw and pressed wood was determined by the stereometric method. The ratio of the bulk density to the number of counts per minute was constant. The bulk density of the pressed woods was not uniformly distributed over the cross section. (M.C.G.)

325 RADIONUCLIDES AND IONIZING RADIATIONS FOR DETERMINATION OF PARTICLE SIZE DISTRIBUTION. Harald Ramdohr. Kerntechnik, 4: 318-20(Aug. 1962). (In German)

Radionuclides and ionizing radiations may be used with several advantages for particle size distribution determinations. They make possible continuous and touchless measurements and eliminate sampling operations. Five different measuring techniques are distinguished: γ-absorption, x-ray-absorption, β-backscattering, κ-ray- and γ-fluorescence, and labeling of solids. Out of these the two last techniques may be interesting for further investigations. The labeling of solids allows detection of finest particles even in low concentrations, a possibility which is not given when absorption techniques are used. (auth)

326 EXPERIENCES IN THE USE OF GAMMA-EMISSION OF RADIOACTIVE Co^{60} AND Cs^{137} ISOTOPES TO CONTROL WELD JOINTS AND CASTINGS AT THE NORIL'SK COMBINE OF MINING AND METALLURGY IMENI A. P. ZAVENYAGIN. Yu. N. Kalenikhin. Radioaktivn. Izotopy i Yadernye Izlucheniya v Nar. Khoz. SSSR, Tr. Vses. Soveshch., No. 3, 52-6(1961).

Information is given on experience in gamma-flaw detection with the use of Co^{60} of 50 and 5 g-equiv Ra intensity for cast steel and brass, and with the use of Cs^{137} of 2 g-equiv Ra intensity for the inspection of steel. The technology of gamma detection, selection of exposures, the individual and integral dosimetry employed, and the interpretation of images on gammagraphs are described. An equation was derived to determine the magnitude of defects according to the gammagraph of thin parts, where, the portion of scattered radiation in the total radiation flux is small, and changes in the radiation composition can be therefore neglected. (Ref. Zh. Met., No. 12, 1961)

327 SELECTION OF ECONOMICALLY EFFECTIVE GAMMA EMITTERS FOR FLAW DETECTION. V. I. Postnikov. Radioaktivn. Izotopy i Yadernye Izlucheniya v Nar. Khoz. SSSR, Tr. Vses. Soveshch., No. 3, 57-61(1961).

A study was made for the purpose of establishing the limits of the most efficient use of gamma emitters, and of developing optimum limits of applying and selecting gamma emitters on the basis of technical and economical indices. Nomograms were plotted which can be used to select both the source and its operational conditions, in order to assure highest inspection efficiency at minimum expense. Gammagraph expenses were established as a function of such factors as the thickness of metal to be inspected, type and intensity of the source, and industrial conditions. Comparison graphs make it possible to draw conclusions as to the limits of the most effective use of the analyzed sources. For up to 100 mm thick metal, independent of the source intensity, Ir, Cs, and Eu were concluded to be preferable to Co, in respect to efficiency, transportation time, and expenses. The apolication limit may be 60 mm for Ir, 100 mm and more for Cs and Eu. It is not recommended that Tu be used on a thickness of over 10 to 15 mm. Co should be employed for >80 mm thick metals. Data are also presented on the use of gamma-flaw-detection at industrial enterprises and the economical effect obtained. (Ref. Zh. Met., No. 12, 1961)

328 COBALT-60 RADIATION IN RESEARCH AND PRODUCTION PROCESSING. A. J. Felice (Atomic Energy of Canada Ltd., Ottawa). Preprint. [Ottawa], Canadian Nuclear Association, 1962. 8p.

Co^{60} radiation research facilities available and in use are described briefly. Their cost is estimated. Examples of applications of Co^{60} to production processing are given. (A.G.W.)

INSTRUMENTS AND INSTRUMENTATION

General and Miscellaneous

Refer also to abstract 15.

329 (CEA-2184) DENSIMETRE ENREGISTREUR POUR LIQUIDES SPECIALEMENT ADAPTE AU DOSAGE CONTINU DE L'EAU LOURDE. (Recording Hydrometer for Liquids Especially Adapted to the Continuous Measurement of Heavy Water). S. Chatel and G. Nief (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). 1962. 25p.

A glass float, containing a magnetic device, is immersed in the water whose density is to be measured. It is free to move between two stops inside a differential transformer excited by an alternating current. The signal thus produced has an amplitude which increases with the distance separating the float from the lower stop. This signal is amplified, rectified, filtered, and re-amplified. The current obtained passes through a coil which attracts the float downward. The float comes to rest such that the upward thrust is exactly compensated. The intensity of the corresponding current is recorded. The concentration of D_2O in water can be measured at 0 to 8% with a relative error of about 0.3% with an absolute possible error of under 20 deuterium atoms per million (approximately 0.002%). (auth)

330 (CLM-R-22) THE STATISTICAL ACCURACY OF MEASUREMENTS OF FLUCTUATING QUANTITIES IN PULSED DEVICES. M. G. Rusbridge (United Kingdom Atomic Energy Authority. Research Group. Culham Lab., Culham, Abingdon Berks, England). July 1962. 18p.

The statistical accuracy of the root mean square level estimates for a fluctuating signal with zero mean value is calculated for the case in which the individual readings cannot be assumed to be completely independent. The accuracy is specified by the "effective number" of independent readings which would give the same accuracy. An expression is also given for the effective number when the estimate is obtained by continuous electronic averaging. Numerical results are given concerning specific forms for the auto-correlation function of the original fluctuating signal. Features of these results which are likely to occur in general are pointed out. A criterion is suggested for choosing the optimum number of readings. (auth)

331 (FD-86) DIMENSIONAL MEASUREMENTS ON IRRADIATED FUEL BUNDLES USING DIFFERENTIAL TRANSFORMER INSTRUMENTATION. J. Christie and A. S. Bain (Atomic Energy of Canada Ltd., Chalk River, Ont.). Aug. 1962. 17p. (AECL-1603)

Lengths, diameters, and profiles of NPD-2 and CANDU type fuel bundles were measured before and after irradiation by the use of linear differential transformers mounted into suitable fixtures. The output signals from the transformers were fed into chart recorders. The accuracy of individual measurements depended on the accuracy of the fixtures, but was generally ±0.02 mm (0.001 in.) on diameter and profile measurements, and ±0.05 mm (0.002 in.) on length measurements. A comparison of the pre- and post-irradiation charts has allowed a rapid assessment of the dimensional stability of the fuel. (auth)

332 (HW-57662) THE DEVELOPMENT OF THE HLO PIPELINE PLUTONIUM MONITOR. An Interim Summary. R. D. Dierks (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 13, 1958. Contract AT(45-1)-1350. 19p.

Developmental work on an instrument capable of indicating continuously the concentration of Pu in a solution flowing in a standard pipe line is described. Experimental sensing units for use in such lines are described, and data that were obtained from these units and in laboratory experiments are discussed. It is concluded that the Pu monitor has the potential of becoming a good in-line instrument; however, further investigation of the neutron flux measuring techniques are required before it is acceptable. (J.R.D.)

333 (IM-48) INSTRUCTION MANUAL—HEAVY WATER ANALYSER (ROTATING FILTER SPECTROMETER). J. G. Bayly and R. J. Booth (Atomic Energy of Canada Ltd., Chalk River, Ont.). Aug. 1962. 28p.

A number of rotating filter infrared analyzers were developed for measuring the isotopic composition of water. The operating principles of these monitors, which respond to the optical absorption caused by the HDO impurity in either H_2O or D_2O, are outlined. Technical details of the spectrometers are discussed. (auth)

334 (JAERI-4022) SEMICONDUCTOR MODULATORS FOR D.C. AMPLIFIERS. Chiyoji Kawaguchi, Naoaki Wakayama, Tsunemi Kakuta, Tomozo Hurukawa, Katsuyuki Ara, Hiroshi Yoshida, and Tomohide Kawakami (Japan Atomic Energy Research Inst., Tokyo). June 1962. 36p.

A survey of semiconductor modulators for d-c amplifiers was made. The survey shows that transistor and diode modulators are replacing contactor and capacity modulators due to the development of improved semiconductors. The principles and development history of semiconductor modulators are discussed along with a-c modulators. The characteristics of the respective modulators are tabularly summarized. (auth)

335 (NYO-10471) DEVELOPMENT OF HIGH SPEED ELECTRON ACCELERATOR STRUCTURES. Final Report, November 1, 1960–June 30, 1962. (David Sarnoff Research Center, Princeton, N. J.). Contract AT(30-1)-1958. 43p.

D-c current measurements and pulse height spectra are used to study the dark current problems of photomultipliers. The dark current sets the lower limit of the useful range of a photomultiplier. The dark current curves were analyzed into two components, one corresponding to the emission of single electrons from the photocathode, the other corresponding to the emission of multiple electrons from the photocathode. The problem of determining the distribution of multiplier output pulses was also studied. Methods for determining how the individual stages of secondary emission contribute to the output pulse distribution were studied. The study of the energy dissipation necessary to produce a photon in, and of the decay time of, several phosphors was done using conventional image converter tubes in the system. Schematic designs are presented of several tubes. (N.W.R.)

336 (TID-16859) DESIGN AND CONSTRUCTION OF A LARGE MAGNETIC-FIELD SPARK CHAMBER SYSTEM. G. R. Burleson, T. F. Hoang, P. I. P. Kalmus, R. L. Kuskowski, L. Q. Niemela, A. Roberts, T. A. Romanowski, S. D. Warshaw, and G. E. Yurka (Argonne National Lab., Ill.). July 1962. Contract [W-31-109-eng-38]. 11p. (UAC-6660)

The design is based on earlier experience with smaller magnetic-field systems. Details are included concerning the magnet, spark chambers, pulsers, counters, data box, and the geometry of the system. (J.R.D.)

337 (TID-16861) OPTICAL SYSTEM AND DATA PROCESSING FOR A LARGE SPARK CHAMBER SYSTEM IN A MAGNETIC FIELD. G. R. Burleson, J. A. DeShong, T. F. Hoang, P. I. P. Kalmus, R. L. Kuskowski, L. G. Niemela, A. Roberts, T. A. Romanowski, S. D. Warshaw, and G. E. Yurka (Argonne National Lab., Ill.). July 1962. Contract [W-31-109-eng-38]. 6p. (UAC-6658)

The design of the optical system and the method of extracting data from photographs are planned to be independent of the particular experiment being performed as far as is feasible. A discussion of the optical system parameters is presented, and details of photograph evaluation, track reconstruction, and precision of this procedure are given. (J.R.D.)

338 (TID-16884) PNEUMATIC SERVO ACTUATOR. C. B. Sung (Bendix Corp. Research Labs. Div., Southfield, Mich.). [nd.] Contract [AT(29-2)-705]. 11p.

A room-temperature pneumatic rock actuator was completed. Tests performed on the unit include open- and closed-loop dynamic response, closed-loop stiffness, and friction. The purpose of these tests was to evaluate various static and dynamic characteristics of the actuator and compare them to the specifications. The tests demonstrated that this concept was not only feasible but superior so that results are being used as a guide in improving the room-temperature actuator design and in designing and constructing a high temperature prototype actuator for driving the control rod of a nuclear rocket engine. (auth)

339 (TID-16885) MODEL 40T ACTUATOR. C. B. Sung (Bendix Corp. Research Labs. Div., Southfield, Mich.). [nd.] Contract [AT(29-2)-705]. 9p.

An electro-pneumatic, linear type actuator was designed. It is a gear type with a displacement of $\frac{1}{2}$ in.^{3} per in. of travel. It has a 20-in. stroke and operates with a supply pressure ranging from 90 to 1000 psi. Principles of operation are discussed. Operating characteristics are described. (M.C.G.)

340 (EURAEC-342) APPARATUS FOR HIGH-TEMPERATURE MICROGRAPHIC EXAMINATIONS. Special Report No. 2, January 1 to March 31, 1962. (Société des Forges et Ateliers du Creusot, Paris). Work Performed under United States–Euratom Joint Research and Development Program. Contract 073-61-12 RDF. 21p. A translation.

An apparatus was developed for continuous micrographic examination throughout a given thermal cycle at high temperatures. The principles and design characteristics of the micro-furnace are described. It was used to study the enlargement of austenitic grain and transformations in the course of rapid coolings in steel. (M.C.G.)

341 AN OPTICAL PUMPING MAGNETOMETER FOR THE STUDY OF THE MAGNETIC FIELD OF SPACE. L. Malnar (Compagnie Generale de Telegraphie Sans Fil, France) and J.-P. Mosnier. Ann. Radioelec., 16: 3-8(Jan. 1961). (In French)

A magnetometer is described that is based on the magnetic resonance of cesium vapor. Optical pumping is used to produce and to detect resonance. A laboratory model is designed and its performance studied. The sensitivity of the model is 0.1 to 1.0 γ. (auth)

342 PIRANTI GAUGE WITH AUTOMATIC CONTROL. István Berecz and Bálint Schlenk. Magy. Tud. Akad. At. Kut. Int. (Debrecen) Kozlemen., 4: 33-5(May 1962). (In Hungarian)

A vacuum gage operating on heat conduction basis is described. The instrument works reliably in a pressure range of 1 to 10^{-3} mm Hg and is equipped with a relay connection by which it is possible to switch it on and off automatically within the pressure range above at a pre-set pressure value. (auth)

343 PREAMPLIFIER FOR REACTOR START-UP CHANNEL. Eiji Kaneko (Hitachi Ltd., [Tokyo]). Nippon Genshiryoku Gakkaishi, 4: 614-20(Sept. 1962). (In Japanese)

Design factors of a preamplifier for use in the start-up region of nuclear reactors are discussed. A transistorized preamplifier is developed. Experimental data of this device are as follows: internal noise (at input terminal), less than 8 μv; gain, about 41 db; dynamic range (at output terminal), 0.9 mv to 10 v; pulse resolution, better than 0.5 μsec; input impedance, about 5.6 kΩ; output impedance, about 40 Ω; and amplitude stability, better than $\pm$0.5% for d-c source-voltage change of $\pm$10% or room temperature change of 0 to 45°C. (auth)

344 THEORY OF NEGATIVE RESISTANCE CHARACTERISTICS IN IRRADIATED GAS THERMIONIC DIODES. R. Forman (Union Carbide Corp., Parma, Ohio). Phys. Rev., 128: 1487-92(Nov. 15, 1962).

A theory explaining negative resistance effects in the anode current-voltage characteristics of inert gas-filled thermionic diodes exposed to ionizing radiation is proposed. The theory shows that these effects are observed in argon-, krypton-, and xenon-filled diodes under appropriate conditions of anode spacing, gas pressure, and radiation dosage because these gases have a Ramsauer minimum in their electron scattering cross-section data. The theory also shows that gases not having this anomaly in their scattering cross section, such as neon or helium, do not show negative resistance effects. (auth)

345 ELECTRICAL CONDUCTION THROUGH RADIATION-PRODUCED PLASMAS IN INERT GAS THERMIONIC DIODES. R. Forman, J. A. Ghormley, and J. R. Reiss (Union Carbide Corp., Parma, Ohio). Phys. Rev., 128: 1493-6(Nov. 15, 1962).

Properties of thermionic diodes containing inert gases at pressures from 1 to 600 Torr have been determined during irradiation with gamma rays and 1-Mev electrons at dose rates to 3×10^8 rads/h. Anode current maxima were observed at applied potential less than 4 V in tubes containing argon, krypton, or xenon, the gases having Ramsauer minima in their scattering cross sections. Negative resistance in the tube characteristics was not observed with helium, neon, or nitrogen which do not have scattering cross-section minima. Negative resistance was observed in diodes having both planar and cylindrical geometry. With all of the rare gases initiation of breakdown occurred, during irradiation, at applied potentials less than the ionization potentials of the gases. The diode current at a constant anode voltage increased linearly with dose rate at low radiation intensities and approximately as the square root of dose rates at higher intensities. (auth)

346 EVALUATION OF HIGH-TEMPERATURE STRAIN GAGES FOR ENRICO FERMI REACTOR VESSEL. F. R. Beyer and J. O. Smith (Atomic Power Development Associates, Inc., Detroit and Detroit Edison Co.). Proc. Soc. Exptl. Stress Anal., 19: No. 1, 81-8(Mar. 1962).

Thermally induced strains in the Fermi reactor vessel will be measured with weldable strain gages during tests prior to criticality. Laboratory tests of these gages show

that mechanical strains can be measured under static conditions at 900°F. Laboratory tests further show that the temperature coefficient of these gages becomes very small after about 170 hr of heating at 900°F, making it possible to measure strains resulting from temperature changes. (auth)

347 REMOTE MEASUREMENTS OF WATER CONTENT IN SNOW BY MEANS OF NUCLEAR RADIATION. A. M. Dimaksyan. Tr. Gos. Gidrolog. Inst., No. 87, 27-45 (1962). (In Russian)

The mean square of a single measurement is about ±9 mm of water equivalent in snow, the relative error is 5% of measured volume. It is shown that the absorption equivalent of water in snow depends on the container, distance between the source and detector, and the height of the snow layer between them. (tr-auth)

348 STABILITY OF BASE METAL THERMOCOUPLES DURING EXPOSURE TO VARIOUS ATMOSPHERES. W. T. Rainey, Jr. and R. L. Bennett (Oak Ridge National Lab., Tenn.). ISA Preprint No. 60.2.62. Pittsburgh, Instrument Society of America, 1962. 9p.

Extensive testing of base metal thermocouple alloys under marginally oxidizing conditions showed that selective oxidation of chromium often occurred in ISA Type K positive alloy (Chromel-P, etc.), causing development of reduced emf output. Such results were obtained with bare wire and stainless steel-sheathed couples in atmospheres thought to be inert or non-oxidizing. Thermodynamic calculations substantiated the suggested mechanism of damage. (auth)

349 ELECTRICAL MEASUREMENTS THROUGH VESSEL WALLS. E. H. deGrey and J. G. Bayly (Atomic Energy of Canada Ltd., Chalk River, Ont.). ISA Preprint No. 60.4.62. Pittsburgh, Instrument Society of America, 1962. (Prepublication Copy). 4p.

A system was developed which permits the measurement of resistance or capacitance through the walls of a closed vessel of non-ferromagnetic material. It does not require electrically insulated leads through the vessel walls. The resistance or capacitance may be a transducer sensitive to temperature or pressure or some other parameter of interest. The accuracy is comparable to other methods, requires no close tolerances of mechanical parts, and can be used in conjunction with standard self-balancing recorders or modern electronic data processing systems. (auth)

350 IMPROVEMENTS IN OR RELATING TO MEASURING APPARATUS. William Thompson and Frank Roper Berry (to United Kingdom Atomic Energy Authority). British Patent 906,706. Sept. 26, 1962.

An apparatus is designed for measuring the over-all length and weight of a column of fuel pellets prior to insertion into a can. The apparatus comprises a channel, means at one end of the channel for feeding pellets one by one into the channel, detector means at the other end movable by the leading pellet of the column, means for arresting the pellet feed when the detector movement exceeds a lower limit, and means for indicating when the detector movement exceeds an upper limit. Pivoting means is provided for indicating whether the weight of the column falls within tolerance limits. (D.L.C.)

351 APPARATUS FOR MEASURING THE THICKNESS OF A DEPOSIT. Pierre Pascal Martinelli (to Commissariat à l'Énergie Atomique). U. S. Patent 3,056,027. Sept. 25, 1962.

A radiometric apparatus is designed for measuring deposit thicknesses. In this apparatus, a beam of beta rays is projected onto the deposit, and the excited x rays are detected in a frequency band including one of the x-ray characteristics of the deposit. The x-ray activity serves as an indication of the deposit thickness. A magnetic field is provided between the deposit and the detector means to block scattered beta rays. (D.L.C.)

Radiation Detection

352 (AE-84) INVESTIGATION OF THE PULSE HEIGHT DISTRIBUTION OF BORON TRIFLUORIDE PROPORTIONAL COUNTERS. I. O. Andersson and S. Malmskog (Aktiebolaget Atomenergi, Stockholm). Aug. 1962. 22p.

An investigation of the factors that determine the pulse-height distribution from thermal neutron irradiated BF_3 proportional counters is described. Measurement of the $B^{10}(n,\alpha)Li^7$ thermal neutron reaction branching ratio is also reported. (J.R.D.)

353 (AERE-M-1075) QUENCHING AND ADSORPTION IN LIQUID SCINTILLATION COUNTING. Horace E Dobbs (United Kingdom Atomic Energy Authority. Research Group. Wantage Research Lab., Wantage, Berks, England). Aug. 1962. 17p.

The possibility of increasing the counting efficiency for carbon-14 in a coincidence liquid scintillation system by optimizing the voltages on the photomultipliers for all concentrations of quenching agent is demonstrated. A similar effect is not observed for tritium. An increase in count rate was observed, under optimum conditions, when small concentrations of quenching agent (benzoic acid) were added to a phosphor solution containing carbon-14 labeled adipic acid. This was shown to be due to desorption of the active specimen, part of which was adsorbed on the walls of the counting phial. Some of the practical aspects of optimization and adsorption are discussed. (auth)

354 (AERE-R-3968) A GAS ČERENKOV COUNTER FOR USE AT NIMROD. W. Galbraith, G. Manning, and A. G. Parham (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). July 1962. 17p.

A Cherenkov counter is described for use at Nimrod where identification of π and K mesons and protons at momenta about 5 Bev/c is desirable. The information is presented in sections concerned with gas handling equipment, measurement of gas refractive index, and counter calibration. (M.C.G.)

355 (AF-SAM-62-28) LIGHTWEIGHT RECOVERABLE COSMIC-RAY DETECTORS. A FILM BADGE DOSIMETER. Loren C. Logie, Joseph S. Pizzuto, John E. Pickering, and Fred Yablinsky (Texas. Univ., Austin. Radiobiological Lab.). Sept. 14, 1961. 8p.

Development of a film-badge dosimeter for the rapid determination of effective energies below 200 kev of unknown electromagnetic radiations is described. The response of this dosimeter was calibrated for x radiation at 24 to 198 kev. Data are also included which correlate film densities with Co^{60} gamma radiation, 14 and 730 Mev protons, and 900 Mev alpha particles. Variances caused by film processing are also discussed. (J.R.D.)

356 (CREL-1073) A PUNCHED-CARD READOUT SYSTEM FOR NEUTRON TIME-OF-FLIGHT ANALYZERS. J. Leng and T. K. Alexander (Atomic Energy of Canada Ltd., Chalk River, Ont.). July 1962. 65p. (AECL-1604)

The combination magnetic-tape and magnetic-core time-of-flight analyzer at Chalk River has a capacity of 16,200 channels, each channel having a word length of 16 binary bits. Part of the readout apparatus for this analyzer includes a punch-card system capable of recording the data

in blocks of 900 channels. The majority of data is punched in binary format, requiring 19 cards for 900 channels and taking only 12 seconds to complete. The output cards also contain data from various monitor scalers and experiment switch settings. Following readout the cards can be fed back through the card-punching machine and checked for parity errors. The readout system contains 1300 diodes and 500 transistors, the failure rate for these being 0.15 and 0.27% per annum, respectively, for the first 18 months of operation. (auth)

357 (CRRD-1102) MEASUREMENTS OF γ-RADIATION DAMAGE TO pn JUNCTION γ-RAY DETECTORS. A. R. Jones (Atomic Energy of Canada Ltd., Chalk River, Ont.). Sept. 1962. 10p. (AECL-1607)

High-resistivity p-n junction detectors and Li drift detectors were exposed to gamma radiation doses at 10^3 to 2×10^7 roentgens in decade steps. Between each exposure the noise counting rates and gamma sensitivities were measured. A group of controls, which were not exposed, were measured at the same time. The results so obtained are presented graphically. No deterioration was observed until a dose of 10^6 roentgens was reached. A transistor preamplifier was also irradiated at the same time, and its noise performance was measured as a function of dose. (auth)

358 (EURAEC-51) SOLID STATE NEUTRON DETECTOR. Quarterly Report No. 1. (Brussels. Centre d'Etude de l'Energie Nucléaire). 1960. Work Performed under United States–Euratom Joint Research and Development Program. Contract 029-60-10RDB. 40p.

Activities in a program to examine the possibilities of using SiC in high-temperature neutron-resistant radiation detectors are reported. A number of grown p-n junctions were obtained and properties such as the photocurrent, the photovoltaic effect, and capacity as function of reverse bias were measured. An instrument for semi-automatic measurement of current-voltage junction characteristics during irradiation in the reactor was finished. Data on the characteristics of a number of junctions after irradiation were obtained. (J.R.D.)

359 (HW-61743) RUBBER RING DOSIMETER CALIBRATIONS WITH THE PLUTONIUM RADIATION SPECTRUM. F. Swanberg, Jr. and B. V. Andersen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 2, 1959. Contract W-31-109-eng-52. 7p.

Rubber finger ring film packets (pads) and conventional personnel monitoring film badges were exposed to radiations from plutonium metal. The resulting data were treated to yield estimates of the surface dose rate from plutonium pieces, and the ratio of the film darkening per unit dose of plutonium gamma to the film darkening per unit dose radium gamma. (auth)

360 (NP-12159) RADIATION DAMAGE EFFECTS IN SEMICONDUCTOR NUCLEAR PARTICLE DETECTORS. Final Report. (Solid State Radiations, Inc., Los Angeles). Aug. 1960. Contract DA-49-186-ORD-1013. 55p.

The effects of fast neutrons and Co^{60} gamma rays on semiconductor nuclear particle detectors were studied. Commercially available silicon p-n junction detectors as well as silicon surface barrier detectors were irradiated with Co^{60} gamma rays to a total dosage of 10^7 roentgens and irradiated with 14-Mev neutrons to a total integrated flux of 10^{13} neutrons. The effects of radiation damage on the dectors were determined by measuring the current-voltage characteristic, the noise versus voltage characteristic, and the capacitance-voltage characteristic as a function of the integrated dose. (auth)

361 (NYO-9360) A FAST NEUTRON TIME OF FLIGHT SYSTEM FOR USE WITH CYCLOTRONS. H. W. Fulbright, J. W. Verba, V. K. Deshpande, and A. K. Hamann (Rochester, N. Y. Univ.). Aug. 16, 1962. Contract AT(30-1)-875. 32p.

A reference pulse generator, transistorized time-difference-to-pulse-height converter, and beam pulse scaler are described and discussed as to their function in the fast neutron time-of-flight system for use with cyclotrons. The system is used for angular distribution and cross section measurements. Results are presented showing time resolution, absolute counting efficiency, and beam pulse scaling of the system. (N.W.R.)

362 (RISO-42) THE SWITCHING TIME OF A TUNNEL DIODE. B. C. Kim (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). June 1962. 35p.

The switching time is evaluated by dividing the voltage-current characteristic curve of a tunnel diode into four regions. The switching time for each region is calculated and compared with the value observed, operating the tunnel diode as a monostable multivibrator. Prediction of the switching time is also made when the tunnel diode is biased by a current generator and is triggered by a current pulse. A voltage-pulse-height discriminator is described, and the threshold equation is given. The linearity, pulse resolving ability, and the temperature characteristics are studied. The threshold variation due to the ambient temperature variation is attributed to the peak current variation. (auth)

363 (UCRL-10374) DIVERSIFIED APPLICATIONS OF BASIC ALPHA INSTRUMENTATION. William J. Roach and Robert J. Walker (California. Univ., Berkeley. Lawrence Radiation Lab.). July 1962. Contract W-7405-eng-48. 9p.

A building block method composed of several simple basic units that are easily combined into more complex units is described as a basis for alpha instrumentation of small size, low cost, and flexibility. Such problems as airborne alpha detection, detection and recording of fast or thermal neutrons, area alarms for alpha or beta-gamma radiation or neutrons, and large-area floor and hallway alpha survey devices were satisfactorily solved by this method. (auth)

364 (USNRDL-TR-572) A METHOD FOR THE ANALYSIS OF COMPLEX PEAKS OCCURRING IN GAMMA RAY PULSE HEIGHT DISTRIBUTIONS. C. L. Carnahan (Naval Radiological Defense Lab., San Francisco). July 17, 1962. 41p.

A method is described which can be used to compute the areas of overlapping peaks occurring in gamma-ray pulse height distributions in which the data are obtained in the form of histograms. The method is applicable to the study of nuclear decay schemes and to the analysis of mixtures of radionuclides. The method can also be used to determine the energy of a gamma ray giving rise to a peak which is obscured by one or two other peaks from gamma rays of known energies. The method is based on the assumption that the events contributing to peak area are distributed about a central location according to the normal probability distribution. Prior calibration of the pulse height analyzer with sources of known energy is necessary for the application of the method. (auth)

365 (USNRDL-TR-584) QUALITY CONTROL FOR THE GAMMA-RAY SCINTILLATION SPECTROMETER. D. F. Covell (Naval Radiological Defense Lab., San Francisco). Sept. 17, 1962. 26p.

Fluctuations, drifts, or performance abnormalities in the scintillation gamma-ray spectrometer may completely invalidate its calibration and, under any circumstance, will

lessen its precision of measurement. A technique patterned after well-established methods of quality control was found to be effective in significantly reducing drift and providing a continuous evaluation of spectrometer performance. An additional benefit in applying this technique was the gradual improvement in instrument reliability with a resultant reduction in the requirement for special maintenance. (auth)

366 (AEC-tr-5369) SEMICONDUCTOR SPECTROMETERS FOR CHARGED PARTICLES. L. A. Zubritskii, A. I. Popov, P. V. Sorokin, and V. F. Samoilov. Translated from p. 591-7 of "Proceedings of the Conference on Nuclear Electronics, held in Belgrade, May 15-20, 1961. Vol. I" (a publication of the International Atomic Energy Agency, Vienna, 1962). (STI/PUB/42(Vol.I)(p.591-7)). 10p.

A method of making germanium and silicon spectrometers is described along with their design and properties. At the temperature of liquid nitrogen and germanium spectrometers with an area of 5×5 mm^2 have a resolution of not less than 0.5% for alpha particles of Po^{210} at voltages of up to 30 volts. At the temperature of liquid nitrogen the silicon spectrometers with an area of 4×4 mm^2 have a resolution of 2.5% at voltages from 50 to 180 volts. At room temperature the silicon spectrometer has a resolution of 3% at voltages of up to 10 volts. (auth)

367 RADIATION DETECTORS UTILIZING SEMICONDUCTORS. Hisanobu Kobayashi. Denshi Gijutsu, 3: 69-71(July 1961).

A semiconductor generates pulses proportional to the energies of the incident particles. Surface barrier type and p-n junction type semiconductors are available. These semiconductor-type detectors are compact and durable, and they do not require high voltages, flow and quenching gases, end-window counters, or photomultipliers. The rising time of the output pulse is very short. Neutrons can be detected by (n,α), (n,p), and (n,γ) reactions. Physical theories on the mechanism of semiconductors are discussed. Germanium p-n junction detectors require cooling because of the noise at room temperature. Silicon p-n junction detectors are currently popular. A linear relationship between the pulse-height value and the radiation energy can be maintained with a suitable bias voltage up to 4.5 Mev for protons and 20 Mev for α particles. The resolution of α particles at 6 Mev is about 0.6%. (OID)

368 THE MEASUREMENT OF WEAK β RADIATION WITH A NEW TYPE GEIGER-MUELLER COUNTER ARRANGEMENT. M. Marxen (Valvo GmbH, Ger.). Elektron. Rundschau, [14]: 55-7(1960). (In German)

In the measurement of weak β radiation, the oscillation and uncertainties of the background form the largest source of error. A counter arrangement, consisting of a β counter and a protecting counter tube, is described which makes it possible to reduce the value of the background to < 1 count/min. This is done through material screening of the γ radiation and electrical screening of the mesons in an anticoincidence circuit. The entire device is very compact and is very economical with respect to shielding materials in comparison with the usual shielding methods. (tr-auth)

369 A PORTABLE RADIATION DETECTION INSTRUMENT WITH GEIGER-MUELLER COUNTERS. H. Mahnau. Elektron. Rundschau, [14]: 87-9(1960). (In German)

A radiation detection instrument of high sensitivity is described which, in addition to the emitting counter tubes, uses exclusively semiconductors. The apparatus is used for γ dose measurements and is suitable also for the relative measurement of α and β when used with supplementary probes. Since the circuit contains largely pulse transformers with ferrox cubic cells, the utilization of active quadrupoles was limited to a minimum. (tr-auth)

370 MECHANICAL COUNTING DEVICES IN RADIATION MEASUREMENT TECHNIQUES. T. Friese (Hahn-Meitner-Institut für Kernforschung, Berlin). Elektron. Rundschau, [14]: 357-61(1960). (In German)

The resolution possibilities of mechanical counting devices are so low that they can be used in radiation measurement techniques only seldom for the direct pulse counting of statistically distributed pulses. By connecting electronic reduction stages, however, the resolution of the counting device can be greatly improved. Error curves are given for various reduction ratios. For monitoring installations, the introduction of count printers is expedient. These are adapted to the desired application by pre-reducers or by a series-connected accumulator that has been tested at a suitable frequency. Measurements with a simple radiation measurement device confirm the calculated error curves. (tr-auth)

371 PLOTTING OF COUNTER TUBE CHARACTERISTICS ON THE OSCILLOGRAPH SCREEN. H. Schmidt and H. Schmidt (Institut für Medizin und Biologie der Deutschen Akademie der Wissenschaften, Berlin). Elektron. Rundschau, [14]: 413(1960). (In German)

The characteristics of a counter tube depend essentially on the filling gas, the gas pressure, and the material and dimensions of anode and cathode. A circuit for the oscillographic observation of tube characteristics is given, and the principle of its operation is described. (J.S.R.)

372 SEMI-CONDUCTORS AS RADIATION DETECTORS. W. Kessel. Elektron. Rundschau, 16: 147-50(Apr. 1962). (In German)

Semiconductors, operating in the high-resistance region, find application as radiation detectors. By means of the best known radiation detection methods, the transformation of the radiation energy into electric pulses is described. The operation, practical performance, and pulse form of semiconductor detectors are treated. A discussion of the advantages and disadvantages of these detectors follows. Circuits, which are necessary for the amplification of output pulses, are given in conclusion. (tr-auth)

373 INSTRUMENTATION FOR FULL SCALE TECHNICAL RADIOACTIVE TRACER EXPERIMENTS. Roy A. Allingham and Erik Somer (Danish Isotope Centre, Copenhagen). Ingeniøren, 4: 91-8(Sept. 1960). (In English)

Some of the instruments and devices in current use at the Danish Isotope Center for full scale technical investigations are described. For safe and reproducible introduction of activity into the system there have been developed a number of devices operated by compressed air remotely controlled by solenoid valves. A device that simulates a sewage outlet in the sea, an apparatus for the laying out of experiments, and instrumentation for air flow measurements in industrial drying plants are described. A scintillation detector for general industrial use and one for littoral drift experiments are described. For most of the experiments a system consisting of a scaler, ratemeter, and recorder is used. An accumulator-driven, transistorized scaler specially made for field tracer experiments is described. The scaler gives output pulses with a variable scale factor which are used to operate an edge marker pen on the recorder, thus giving a continuous integration of the ratemeter curve which is recorded simultaneously. This arrangement facilitates the evaluation of the recordings.(auth)

374 AN ELECTRONIC DOSIMETER FOR COBALT THERAPY. A. Bercy, J. Défléchereux, P. Desaive, and J. Garsoux (Université, Liegè, France). J. Radiol., Electrol. Med. Nucl., 38: Nos. 5-6, 445-7(1957). (In French)

The problem of measuring the dose received from a rotating Co^{60} therapy unit can be reduced, from an electronic viewpoint, to the problem of integrating a continuous voltage varying slowly as a function of time and to the problem of remote-control transmission of the integrated magnitude. The apparatus designed consists of two parts. In the first are the integrator, its auxiliary systems, remote-control transmission system, and their feeds, all of which are on the rotating frame. The second part contains the receiver system which is placed in the control room. The integrator circuit is described in some detail. (J.S.R.)

375 AUTOMATIC DEVICE FOR REACTOR RADIATION FIELD MEASUREMENTS. Lubomir David, Josef Smrtka, and Jaroslav Vojta (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Jaderna Energie, 8: 181-4(1962). (In Czech.)

The design and operation of an automatic device for mapping fields of nuclear radiation coming from horizontal experimental channels of a reactor are described. Some results of measurement are reported and further possibilities of the use of the device are indicated. (auth)

376 CZECHOSLOVAK SEMICONDUCTOR DETECTORS OF CHARGED PARTICLES. Marie Skrivankova (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague) and Zdeněk Trousil. Jaderna Energie, 8: 319-26(1962). (In Czech.)

Silicon surface barrier detectors were prepared and tested. Energy resolution for alpha particles was analyzed for the effects of bias, temperature, and incident beam collimation. The best energy resolution was found to be 0.3%. The properties of the detectors as proton spectrometers were also investigated at 6.5 Mev. (D.E.B.)

377 MEASUREMENT APPARATUS FOR LOW ENERGY BETA PARTICLES. Milos Lokajiček. Jaderna Energie, 8: 326-7(1962). (In Czech.)

Measurements of C^{14} are described. Methods used are evaluated and the possibilities of C^{14} detection with the aid of liquid scintillators are enumerated. Experimental work was intended to the evaluation of two possible solutions: of single-channel equipment and of coincidence apparatus with two photomultipliers. The single-channel equipment was designed using wide-window pulse amplitude analyzer. Beta radiation was detected with the aid of liquid scintillators-toluene and dioxane. (auth)

378 EQUIPMENT WITH FAST IONIZATION CHAMBER FOR MEASURING ALPHA ACTIVITIES. H. Mahnau (Abteilung für Strahlennebgeräte der Herfurth GmbH, Hamburg). Kerntechnik, 4: 321-2(Aug. 1962). (In German)

A pulse ionization chamber gives the possibility of measuring alpha activities even in the presence of a beta background. A measuring equipment is described which contains an ionization chamber with air under normal atmospheric pressure, a pulse amplifier, a discriminator, a scaler, and an oscilloscope. The scope shows the single pulses and the level of the discriminator. Accuracy, deadtime, and the effects of different values of beta background are described. (auth)

379 SEMICONDUCTOR DETECTORS. J. Moritz and H. J. Tauffenbach (Gesellschaft fur Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Kerntechnik, 4: 349-50(Aug. 1962). (In German)

Semiconductor detectors are now superior to ionization chambers and scintillation counters in many regions of spectroscopy. The characteristics of semiconductors are reviewed, and possible ways of improving the energy resolution are discussed. The advantages of semiconductor detectors are outlined. (D.L.C.)

380 CONTINUOUS MONITORING OF LOW LEVEL RADIOACTIVE WASTE WATER. Shuji Yamada and Hisashi Yamamoto (Hitachi Ltd., [Tokyo]). Nippon Genshiryoku Gakkaishi, 4: 607-11(Sept. 1962). (In English)

A continuous β monitor utilizing the Cherenkov effect is developed for use with transparent liquid streams. Cherenkov pulses are discriminated from thermal noise in the photomultipliers by coincidence counting and by cooling the photomultipliers. In order to determine optimum measuring conditions, the signal-to-noise ratios are found as functions of the photomultiplier operating voltage, the amplifier gain, and the volume of the detection container. The minimum activity level that can be detected reliably with this apparatus is 0.8×10^{-7} $\mu C/cm^3$ for $Sr^{90}-Y^{90}$, for a counting time of 5 min. (auth)

381 NEW DEVICES FOR THE MEASUREMENT OF THE RADIOACTIVITY IN WATER. Wasser, Luft Betrieb, No. 2, 42-4(1960). (In German)

Effective monitoring of drinking water necessitates measurement apparatus which can establish an increase in the natural radioactivity as quickly as possible. The apparatus must also have high sensitivity with continuous measurement and recording. A water monitor possessing such characteristics is described, and a device for the continuous sampling of water is briefly discussed. (J.S.R.)

382 ELEKTRONNO-FIZICHESKAYA APPARATURA DLYA YADERNOI FIZIKI. NAUCHNO-TEKNICHESKII SBORNIK. VYPUSK CHETVERTYI. (Electronic Devices in Nuclear Physics. (Scientific-Technical Symposium. Vol. 4)). K. F. Kuznetsov, ed. Moscow, Gostamizdat, 1962. 120p.

The construction and performance of transistorized elements of magnetic memory devices and semiconductor triggering schemes are discussed. Schemes are given for a new 100-channel analyzer and for a simple 50-channel amplitude analyzer with dynamic memory and 3 msec dead time. A transistorized coincidence and discriminating scheme (with $\sim 3 \times 10^{-9}$ sec resolving time) for Cherenkov or scintillation counters is also described. (R.V.J.)

383 PULSE-RATE SENSITIVE INTEGRATING CIRCUITS SIMULTANEOUSLY CHARGED BY PULSES AT UNKNOWN RATE AND DISCHARGED AT CONSTANT RATE. Edmund Harry Cooke-Yarborough (to United Kingdom Atomic Energy Authority). U. S. Patent 3,056,047. Sept. 25, 1962.

A ratemeter for electrical pulses is designed which makes an extended count only when the pulse rate of a sample exceeds a predetermined level. The ratemeter comprises a store for pulses, means for emptying the store at a constant rate, means for setting the store to an initial condition, and means for detecting when the net stored pulse count has changed in at least one direction by a predetermined amount. The ratemeter is applicable to alpha monitoring of hands. (D.L.C.)

384 BETA RAY DETECTORS. Johannes Hermsen and Kars van Duuren (to North American Philips Co. Inc.). U. S. Patent 3,056,059. Sept. 25, 1962.

A Geiger-Muller counter for detecting beta rays is designed which has a very low background counting rate and a very good beta counting efficiency. The counter is filled with an ionizable gas containing a halogen quench, and its

anode is shaped spherically on the side facing the window which is also conductive on its inner side and connected to the cathode wall. The dimension of the anode parallel to the window is between 0.15 and 0.75 times the largest cathode dimension parallel to the window, and the height of the discharge space at right angles to the window is between 0.25 and 1.5 times the longest window dimension. The smallest distance of the anode from the window is between 0.1 and 0.5 times the longest window dimension. (D.L.C.)

385 RADIATION ALARM OR THE LIKE. Morris H. Shamos (to Tung-Sol Electric Inc.). U. S. Patent 3,056,123. Sept. 25, 1962.

A sensitive radiation alarm is designed which uses almost no electrical energy in the standby condition. The alarm comprises an ionization chamber, a constant current device in series with the chamber and a source of potential, an electrostatic switch, a gaseous discharge device, and an alarm. (D.L.C.)

ISOTOPE SEPARATION

386 (K-1536) A THEORY OF ISOTOPE SEPARATION IN A LONG COUNTERCURRENT GAS CENTRIFUGE. A. S. Berman (Oak Ridge Gaseous Diffusion Plant, Tenn.). Nov. 2, 1962. Contract W-7405-eng-26. 47p.

A separation theory is presented for use in interpreting the results obtained in experimental work on heavy isotope separation in a long countercurrent gas centrifuge. The theory provides a detailed treatment of the radial concentration variations and is suitable for the description of centrifuge operation at high ratios of product to internal flow. Comparison is made between the predictions of the present theory and those provided by the Cohen theory for several special cases. The theory is also used for comparison with some early experimental observations of Groth and co-workers. (auth)

387 (TID-16712) SEPARATION OF CALCIUM ISOTOPES BY COUNTER CURRENT ELECTROMIGRATION IN MOLTEN SALTS. F. Menes, G. Dirian, and E. Roth (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). July 27, 1961. Contract [AT(30-1)-2429]. 42p.

The enrichment of calcium isotopes by the method of countercurrent electromigration was studied. The electromigration cell, made of transparent quartz, was in the form of a transport number tube, consisting of two reservoirs separated by a diaphragm of alumina or zircon sand. Calcium bromide, with an addition of potassium bromide, was used in the cell. Separation factors ranging from 2.1 to 4.1 were obtained. It was found that the enrichment factors increase almost linearly at the beginning of an experiment and then rather rapidly approach a limit. The mass effect of the calcium ion was found to be 0.060. (M.C.G.)

388 (TID-16715) SEPARATION DES ISOTOPES PAR ELECTROMIGRATION EN SELS FONDUS. (Separation of Isotopes by Electromigration in Fused Salts). F. Menes (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). Dec. 7, 1961. Contract AT(30-1)-2429. 22p.

A process is given for the separation of isotopes by reflux electromigration of fused salts. The process is carried out in a countercurrent manner on a fused mixture of a salt containing the isotopic cations with a salt having the same anion and a cation with a mobility as near as possible to that of the isotopic cations. An electrolytic cell for carrying out the process is described. Examples are presented of the process in which lithium-6 and lithium-7 are separated in a LiBr-KBr mixture, and calcium isotopes are separated in $CaBr_2$–KBr and $CaBr_2$–LiBr systems. (N.W.R.)

389 (TID-16834) SEPARATION OF ISOTOPES. Annual Progress Report. A. R. Gupta, M. Jeevanandam, J. Garbazevich, D. Meranda, Julia Barton, E. Fischbach, S. Golub, H. Taylor, and T. I. Taylor (Columbia Univ., New York). Sept. 1, 1962. Contract AT(30-1)-755. 147p. (CU-15-62AT(30-1)755Chem)

Results of exchange experiments with O^{18} and CO_2 indicate that the overall separation is controlled by exchange at the lower temperatures, measurements of enrichment factors for O^{18} in the exchange of CO_2 with the carbamates of several alkyl and alkanol amines in methanol showed that they decrease in the order primary > secondary > tertiary. Results of measurements on some of the properties of solutions of amine carbamates are summarized. Experiments on the catalysis of nitric oxide exchange with 6M HNO_3 showed that an increase in acidity through the addition of H_2SO_4 significantly increased the exchange rate. Enrichment factors for the exchange of NO_2 with N_2O_4 were measured at −10, 0, and 10°C and at 27 to 300°C. A comparison with the results expected on a simplified model of the system indicated that thermal diffusion effects contribute to the overall separation at higher temperatures. (J.R.D.)

390 (AEC-tr-5383) ENRICHMENT OF B^{10} ISOTOPE BY CHEMICAL EXCHANGE. Istvan Kiss and Istvan Opauszki. Translated for Oak Ridge National Lab., Tenn., from Magyar Kem. Folyoirat, 64: 7-8(1958). 11p.

The chemical exchange method for enrichment of the B^{10} isotope was evaluated. A method for the determination of the B^{10} enrichment based on neutron absorption was developed. This method permits continuous checking of concentration conditions at various points of an isotope enrichment cascade. The enrichment was studied in two experimental apparatuses with BF_3–RBF_3 system where R was anisole in one system and acetic acid in the other. (M.C.G.)

391 (AEC-tr-5384) DATA ON THE SEPARATION OF BORON ISOTOPES. Istvan Kiss, Istvan Opauszky, Lajos Matus, and Janos Torko. Translated for Oak Ridge National Lab., Tenn., from Magyar Tudományos Akad. Kozponti Fiz. Kutato Intézetének Közleményei, 7: 391-8 (1959). 13p.

The enrichment of the B^{10} isotope by the distillation of the complex compounds which are formed by boron trifluoride with organic molecules of different oxygen content and by chemical exchange between the liquid complex and gaseous BF_3 was studied. Furthermore, the isotope effects in the liquid-vapor equilibrium of methyl, ethyl, and n-butyl borates were investigated. It was found that the ether complex appears to be most favorable among the examined complex compounds of boron trifluoride for enrichment of the B^{10} isotope. The value of the enrichment factor with respect to boron isotopes decreased with increasing molecular weight in the case of alkylborates, in contrast to the effect observed in the case of the complex compounds of BF_3. The extent of the isotope effect observed in the distillation of methylborate reached the order of magnitude necessary for practical application in the separation of isotopes. (auth)

392 SEPARATION FACTOR OF DEUTERIUM ON PLATINUM HYDROGEN ELECTRODE IN AQUEOUS SULFURIC ACID. Michiko Fukuda and Juro Horiuti. J. Res. Inst. Catalysis, Hokkaido Univ., 10: 43-72(July 1962). (In English)

The electrolytic separation factor of deuterium on platinum hydrogen electrode in 1.3N H_2SO_4 containing 8.49 atomic percent deuterium was observed in hydrogen atmosphere of 12 cm Hg total pressure at 15°C and different hydrogen overvoltages ranging from 0.02 to 0.55 volt. Thorough vacuum operations were applied to the observation as well as the preparation and purification of materials, the preelectrolysis of the above mentioned aqueous electrolyte, and the cleaning of vessels and electrolytic cell used. The separation factor was determined by measuring the deuterium content of the aqueous electrolyte and that of the hydrogen gas steadily electrolyzed at each constant

overvoltage. It was demonstrated that the separation of deuterium thus observed was caused by genuine electrochemical reaction on the electrode surface but not by some transport process, i.e., the diffusion of hydrogen molecules in the aqueous electrolyte or the evaporation of the electrolyzed hydrogen gas or the diffusion of hydrogen ion. The separation factor was worked out from the observation by an equation, which was derived allowing for the reverse transfer of protium and deuterium for the limiting case of infinitely low deuterium content and demonstrated practically exact, as it is, under the present experimental condition of finite deuterium content. The separation factor thus determined was found to increase from ~3.6 at zero overvoltage to a maximum value ~6.8 around 0.23 volt overvoltage and then slowly decreased down to 6.2 at 0.55 volt overvoltage. The observed initial increase verified the conclusion from the theoretical prediction of Horiuti that the mechanism of hydrogen electrode reaction switches over from the electrochemical to the catalytic mechanism with increase of overvoltage along with the switch of separation factor from the characteristic value ~3 of the former mechanism to that ~7 of the latter one. (auth)

393 A THEOREM ON ELECTROLYTIC SEPARATION FACTORS. Juro Horiuti and Michiko Fukuda. J. Res. Inst. Catalysis, Hokkaido Univ., 10: 73-85(July 1962). (In English)

A theorem $S_l/S_g = S$ was demonstrated for the isotopic separation by irreversible electrolysis in the limiting case of low content of deuterium D in protium P, assuming that the mechanism underlying the electrolysis is one of the electrochemical, catalytic, and slow discharge mechanisms; $S_l \equiv (\Delta P_l/\Delta D_l)/(P_l/D_l)$ or $S_g \equiv (\Delta P_g/\Delta D_g)/P_g/D_g)$ is the forward or the backward separation factor, where $-\Delta P_l$ or $-\Delta P_g$ is the rate of P transferred unidirectionally from aqueous electrolyte to hydrogen gas or reversely, $-\Delta D_l$ or ΔD_g is the rate, with which D is transferred similarly unidirectionally, P_l or D_l is the amount of P or D in aqueous electrolyte and P_g or D_g is that in hydrogen gas; S is the partition coefficient of D between aqueous electrolyte and hydrogen gas defined as the particular value $S \equiv (D_l P_g/D_g P_l)_{eq}$ of $D_l P_g/D_g P_l$ in exchange equilibrium between them. It was shown that the above theorem holds practically for a finite D-content in the experimental condition of the foregoing work, i.e., for 8.49% deuterium in protium, of 1.34N H_2SO_4 over the range of hydrogen overvoltage from 0.02 to 0.55 volt under atmosphere of 12 cm Hg total pressure of electrolyzed hydrogen saturated with water vapor. The theorem is shown exact, on the other hand, for any D-content, provided that the isotopic composition of hydrogen gas is that in exchange equilibrium with the aqueous electrolyte. (auth)

394 THE REMOVAL OF ^{203}Hg IN AQUEOUS SOLUTION WITH MERCURY METAL. Yuichiro Kamemoto and Shigeru Yamagishi (Japan Atomic Energy Research Inst., [Tokyo]). Nippon Genshiryoku Gakkaishi, 4: 611-14(Sept. 1962). (In Japanese)

The removal of Hg^{203} from an aqueous solution with mercury metal is studied. When aqueous 1-N HCl, 1-N HNO_3, and 1-N $NaNO_3$ solutions containing trace amounts of Hg^{203} are shaken vigorously with mercury metal for about 10 min, Hg^{203} is removed from the solution up to 90 or 100%. No appreciable difference in the Hg^{203} removal rates is observed for the different solutions. It may be indicated that Hg^{203} is not simply absorbed on the surface of mercury metal, but is caught on the metal by exchange reaction. It is also found that Hg^{203} is rapidly and completely separated from 0.5-N HNO_3 solution containing about 1 mg/ml Pb. (auth)

395 ORTHO-PARA AND ISOTOPE SEPARATIONS BY PREFERENTIAL ADSORPTION AT LOW TEMPERATURES. David White, W. J. Haubach, and E. N. Lassettre (Ohio State Univ., Columbus). Pure and Appl. Chem., 2: Nos. 1-2, 323-4(1961).

The literature on the separation of ortho- and para-hydrogen and of hydrogen and deuterium by adsorption at low temperatures is reviewed briefly. The prediction of the separations by theory is considered. (D.L.C.)

396 THERMODIFFUSION OF Li-ISOTOPES IN PURE MOLTEN LITHIUM NITRATE. Silas Gustafsson and Arnold Lundén (Technische Hochschule, Göteborg). Z. Naturforsch., 17a: 550-3(July 1962). (In German)

The light Li isotope was enriched at the hot side in thermodiffusion in molten $LiNO_3$. The Soret coefficient is $3.3 \pm 0.2 \times 10^{-5}$ $grad^{-1}$ (probable error indicated) in the temperature range 276 to 425°C. The enrichment in a convection cell agrees satisfactorily with these results. The Soret coefficient and the conversion heat are smaller than in solid Li_2SO_4. (tr-auth)

397 ABTRENNUNG DER FOLGEPRODUKTE ELEKTROLYTISCH ABGESCHIEDENER RADIOISOTOPE DURCH ABLÖSEN VON DER KATHODE. (Separation of Decay Products of Electrolytically Separated Radioisotopes by Dissolution from the Cathode). Max Weber. Thesis, Mainz, Johannes Gutenberg Universität, 1961. 1p.

The separation of radioisotopes on the basis of their electrochemical potentials in dissolution from a cathode was investigated with the system ThC(Bi^{212})/ThC''(Tl^{208}) and Tl^{204}. ThC was separated on the basis of the cathode potential in HCl. After renewal of the electrolyte the ThC was dissolved for 30 minutes and determined in the bath. In spite of variations in acid, acidity, dissolution time, cathode potential, and utilization of reduction agents, the dissolved amount was only 50 to 60% of the ThC'' expected. By investigating the cathode, it was proved that the dissolution of ThC'' can be traced back conclusively to α recoil. Research with Tl^{204} shows that under normal conditions no absorption of the Th on or diffusion into the Pt occurred. Therefore an alloying of these metals is out of the question. The dissolution from the cathode, based on α recoil, has the same velocity as the build up of the daughter substances. The yield in ThC'' is only about half that calculated since almost the same amount penetrates the electrode material. Tl^{204} in approximately 10^{-4}M solution can be brought to the cathode at a potential of −0.32 v. The unexpectedly noble behavior of Tl^{204} is traced to the fact that probably no metallic separation of Tl occurs, only potential dependent adsorption. (tr-auth)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 603, 605, 1008, and 1045.

398 (ANL-6613) TABLE OF TRIM DISCRETE QUADRATURE PARAMETERS FOR THIN BINARY SLAB CELLS. David Meneghetti (Argonne National Lab., Ill.). Sept. 1962. Contract W-31-109-eng-38. 10p.

Discrete quadrature weights and angles for use in discrete ordinate methods of solutions for thin cells were tabulated for a series of regional cell thicknesses of applicability. Parameters are given for 4, 6, 8, 10, and 12 angle approximations. The quadrature assignment was based upon a simplified integral transport solution to the spatial average of the angular distribution of uncollided flux, assuming flat sources. The quadrature assignments are designated TRIM, for thin-region integral method, and are most useful with thin cells having either or both regions very thin in mean-free-path units. The IBM-704 Fortran program used to compute the parameters is described. (auth)

399 (AWRE-0-1/61) MACHINE PRODUCTION OF GROUP CROSS-SECTIONS FOR USE IN CARLSON S_n AND OTHER MULTIGROUP NEUTRONICS CALCULATIONS ON HIGH SPEED COMPUTERS. K. Parker, ed. (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Aug. 1961. 115p.

The AWRE library of neutron cross-section constants is described. The library was accumulated by processing data from the AWRE punched card library of neutron-cross sections using IBM 704 or 709. The principles involved in these programs are very general. (J.R.D.)

400 (CRT-1052) PROP—A COMPUTER PROGRAM FOR CALCULATIONS USING THE OPTICAL MODEL OF THE NUCLEUS. J. M. Kennedy (Atomic Energy of Canada Ltd., Chalk River, Ont.). Oct. 1961. 15p. (AECL-1373)

A program is described for performing optical-model calculations with a Borroughs 205 (Datatron) computer using a Woods-Saxon potential. (J.R.D.)

401 (MSUCP-7) MISTIC GENERAL ORBIT CODE. M. M. Gordon and H. G. Blosser (Michigan State Univ., East Lansing). Sept. 1961. Contract AT(11-1)-872. 71p.

A computer routine is described which is used to integrate the relativistic equations of motion for particles moving in accelerator type orbits. The routine is designed for use in studies of sector focused cyclotrons and is adaptable to a range of other orbit tracking problems. (J.R.D.)

402 (MSUCP-10) MISTIC EQUILIBRIUM ORBIT CODE. T. I. Arnette (Michigan State Univ., East Lansing). Sept. 1961. Contract AT(11-1)-872. 63p.

Details of a code written for the MISTIC computer are presented. The code can be used to locate and determine the properties of equilibrium orbits in cyclotron-type magnetic fields. The equilibrium orbit for a specified particle and energy is that orbit which closes smoothly on itself after 1 revolution, and has the same periodicity as the magnetic field. (J.R.D.)

403 (ORNL-TM-237) OGRE-P2, A MONTE CARLO PROGRAM FOR COMPUTING GAMMA-RAY LEAKAGE FROM LAMINATED SLABS WITH A DISTRIBUTED SOURCE. D. K. Trubey, S. K. Penny, and M. B. Emmett (Oak Ridge National Lab., Tenn.). Aug. 10, 1962. Contract [W-7405-eng-26]. 8p.

A Monte Carlo program OGRE-P2 was written for the IBM-7090 to solve the problem of gamma radiation from a slab of laminated regions composed of various materials. The dose rate is calculated on one side of the slab. (J.R.D.)

404 (ORNL-TM-404) AN ALGOL COMPILER FOR THE CONTROL DATA CORPORATION 1604. Progress Report No. 2. L. L. Bumgarner, A. A. Grau, M. P. Lietzke, R. G. Stueland, and K. A. Wolf (Oak Ridge National Lab., Tenn.). Oct. 18, 1962. Contract [W-7405-eng-26]. 11p.

A summary of the progress on development of the ALGOL compiler for the Control Data Corporation 1604 Computer is presented. This computer is based on machine-independent specifications developed at ORNL. A brief description of the structure of the compiler is included along with discussions concerning language restrictions, the hardware language representation, and the required equipment configuration. An example illustrates the generated program instructions. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

405 (ARF-2198-31) IMPROVED ZIRCONIUM ALLOYS. Quarterly Report, April 1, 1962–June 30, 1962. D. Weinstein and F. C. Holtz (Illinois Inst. of Tech., Chicago. Armour Research Foundation). July 13, 1962. Work performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-578. 17p. (EURAEC-421)

Corrosion and hydrogen pickup data are available on ternary alloys in 680°F water for an exposure time of 4800 hr. In general, the longer the time to transition, the lower the post-transition corrosion rate was. Ternary zirconium alloys were exposed to 750°F steam for a period of 3000 hr. Weight gain and hydrogen pickup values were determined along with tensile properties. (M.C.G.)

406 (ASD-TDR-62-269) SUPERCONDUCTIVITY IN METALS AND ALLOYS. W. H. Cherry, G. D. Cody, J. L. Cooper, J. I. Gittleman, J. J. Hanak, G. T. McConville, M. Rayl, and F. D. Rosi (Radio Corp. of America. RCA Labs., Princeton, N. J.). Jan. 1962. Contract AF 33(616)-6405. 94p.

Methods were developed for the measurement of the interphase energy in superconductors. A description of the method is given along with preliminary results on thin foils and films of Sn. Measurements were made of the thermal contact resistance (Kaptiza resistance) between various solids and liquid He. These measurements were made in the normal and superconducting states for Pb, Sn, and In, and for the insulator sapphire. Measurements were made of the transition temperatures in the system (Nb, Ta, V)$_3$Sn. The transition temperatures range from 2.8 to 18°K and can be related to a simple mass and volume dependence. A new method of preparation of Nb_3Sn was developed and is described in detail. With this method it is possible to prepare crystalline Nb_3Sn and to deposit films of Nb_3SN in various geometries. The application of this technique to the continuous deposition of Nb_3Sn on wire is described, and some superconducting properties of this wire are given. Alloying experiments were made and results indicate ambiguities in the electron-to-atom ratio ascribed to various elements. Resistance measurements on sintered and nonsintered specimens of Nb_3Sn reveal a resistance anomaly near 100°K. (auth)

407 (BM-IC-8053) LITHIUM. A Materials Survey. Albert E. Schreck (Bureau of Mines, Washington, D. C.). Sept. 1960. 81p.

Data on the use, technology, statistics, and history of lithium are presented for the period from its discovery up to December 1959. Information is also presented on resources, material forms, properties, supply and distribution, structure of the industry, research and development, legislation and government, and strategic factors. (N.W.R.)

408 (BM-RI-6057) TRANSFER OF HEAT FROM HELIUM AT HIGH TEMPERATURES. PHYSICAL CHARACTERISTICS OF CERAMIC HEAT EXCHANGERS. John J. S. Sebastian and Stanley C. Browning (Bureau of Mines. Morgantown Coal Research Center, W. Va.). Jan. 1962. 31p.

A laboratory-scale investigation was made concerning the development of a ceramic heat exchanger to operate at high temperatures with He. It was found that the technical feasibility of using such heat exchangers at high pressures depends primarily on development of reliable gas-tight seals and the elimination of high thermal stresses. (J.R.D.)

409 (CEA-2153) DECONTAMINATION DU PLOMB PAR FUSION. (Decontamination of Lead by Fusion). P. Boutot, L. Giachetto, and A. Capitaine (France. Commissariat à l'Energie Atomique. Centre de Production de Plutonium de Marcoule, Chusclan). 1962. 10p.

A fusion decontamination method was developed. The apparatus consists of a propane-heated oven fitted with a steel crucible of 1400 kg capacity, with two ventilation systems, and with a depressometer for preventing the diffusion of toxic gases. There are operational controls on the samples taken before, during, and after the operation, on the plugs taken from the ingots, and on the ingot itself. The continuous sanitary control is done by a radioactive aerosol recorder and by periodic sampling. (auth)

410 (DMIC-175) SUMMARY OF THE SIXTH MEETING OF THE REFRACTORY COMPOSITES WORKING GROUP. W. A. Gibeaut and D. J. Maykuth (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Sept. 24, 1962. 65p.

A summary of information on refractory composites for use above 2500°F is presented. Information is included on protective coatings, insulating ceramics, dispersion strengthening, plasma spraying, high-temperature reactions, and testing techniques. (J.R.D.)

411 (IA-633) TECHNIQUES FOR PRODUCING UNSUPPORTED THIN METAL FILMS. Lecture Notes. (Israel. Atomic Energy Establishment, Rehovoth). Nov. 1961. 9p.

Methods of producing unsupported thin metal films (1000 Å, 5 to 200 $\mu g/cm^3$) are discussed. Vacuum deposition on NaCl crystals and subsequent solution of the latter is discussed as a method along with vacuum deposition on a polystyrene film, which is then dissolved, and anodic oxidation to produce an oxide film on which a metal film can be vacuum-deposited on the oxide film and the latter dissolved. (auth)

412 (KAPL-2221) EFFECT OF HYDROGEN ON THE STRAIN FATIGUE PROPERTIES BY ZIRCALOY-2 WELD METAL. S. Beitscher (Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 26, 1962. Contract W 31-109-eng-52. 33p.

Zircaloy-2 weld metal, obtained by inert-gas, nonconsumable electrode welding, was subjected to low-cycle, strain-fatigue testing. The effects of H_2 contents from 10 to 500 ppm were determined at 400 and 600°F on unnotched and notched specimens. The results indicated that the weld metal is not seriously affected by H_2 under the conditions investigated, and that the fatigue properties are similar to those of wrought Zircaloy-2. (auth)

413 (MLM-1128) MOUND LABORATORY MONTHLY PROGRESS REPORT FOR DECEMBER 1961. J. F. Eichelberger (Mound Lab., Miamisburg, Ohio). Dec. 29, 1961. Contract AT(33-1)-Gen-53. 21p.

An investigation of additives capable of improving heat distortion and impact strength of diallyl phthalate was continued. Work on other elastomers and polymers was also continued. Information and data are included on properties of various adhesive formulations including oxiron

systems. Other work is reported on evaluation of radioelement supply sources. Data on the half-life of Ra^{223} and on coprecipitation of Ra^{223} and La are included. In reactor fuels and materials development, phase equilibria data on Pu-Ce alloys are given along with data on the solubility of PuO_2 in various silicate glass formulations. (J.R.D.)

414 (NMI-2108) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report to United States Atomic Energy Commission, July 1962. (Nuclear Metals, Inc., Concord, Mass.). Oct. 1, 1962. Contract AT(30-1)-2784. 13p.

Activities in an investigation of the effect of purification on the activation of deformation systems of Be with slip directions outside of the basal plane are reported. The effects of specific impurity additions on the mechanical behavior of high-purity Be single crystals are also being studied. Other research is reported on development of refractory metal alloys for use in high-temperature reactors, and on properties of uranium which contains dispersions of small second-phase particles. (J.R.D.)

415 (NMI-2109) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report to United States Atomic Energy Commission, August 1962. (Nuclear Metals, Inc., Concord, Mass.). Oct. 29, 1962. Contract AT(30-1)-2784. 12p.

Progress is reported on investigation of single-crystal deformation in zone-refined Be, development of refractory alloys, development of dispersion-strengthened U alloys, and production of W tubing. (J.R.D.)

416 (NP-12130) RESEARCH ON PHYSICAL AND CHEMICAL PRINCIPLES AFFECTING HIGH TEMPERATURE MATERIALS FOR ROCKET NOZZLES. Quarterly Progress Report. Robert Lowrie (Union Carbide Corp. Research Inst., Tarrytown, N. Y. and Union Carbide Corp. Parma Research Center, Ohio). Sept. 30, 1962. Contract DA-30-069-ORD-2787. 76p.

The oxidation of TiC, TiB_2, ZrC, ZrB_2, HfC, HfB_2, TaC, and TaB_2 by slowly flowing CO_2–Ar mixtures was studied at 2250°C. From these experiments and similar data on tungsten several generalizations were made. Tungsten showed the lowest linear corrosion rate in the range of CO_2 partial pressure studied (50 to 400 Torr). From 100 to 400 Torr of CO_2 HfC had the next lowest linear corrosion rate. The formation and accumulation of nonvolatile oxide coatings on zirconium and hafnium carbides and borides decreased their corrosion rates below those of the other hard metals. Decreasing the porosity also decreased the corrosion rate of all these refractory metals. Progress was made in identifying the solid reaction products remaining on the sample after oxidation by CO_2 or H_2O. A single-surface specimen was developed for study of corrosion at high rates of gas flow, under which conditions it would not be possible to maintain quasi-homogeneous conditions around a six-sided sample. A large increase was found in the rate of corrosion of ZTA graphite by a CO_2–Ar mixture on changing the flow conditions approximately from 20 cm/sec to 10,000 cm/sec. At the high velocity there appears to be a chemical attack on the binder phase and physical erosion of the more resistant particles. An analysis was made of the oxidation of tungsten by CO_2–CO–Ar mixtures on the assumptions that the rate is limited by the attainment of chemical equilibrium at the tungsten surface and by the rates of supply and removal of reactants and products. Results for this system, including the inhibition by CO, are in agreement with the analysis. Future work on inhibition by CO is planned using a nozzle-shaped sample in an engine simulator. Study of the reactions of hydrogen with graphite and with carbides is proceeding. The results for graphite are concordant with first-order kinetics for the formation (first-order in H_2) and decomposition (first-order in CH_4) of methane at the hot carbon surface. Experiments with TiC and NbC were confusing, apparently as a result of contamination of the specimens by oil during grinding. However, in all of the TiC runs and many of the NbC runs no acetylene was detected. This was a very significant difference in behavior from that of graphite, which on reacting with hydrogen under similar conditions produces one hundred times the minimum detectable concentration. The production of other hydrocarbons from these carbides is of the same order of magnitude as from graphite. The mass-spectrometric study of the vaporization of ZrB_2 was completed. A source of error was detected in the presence of temperature gradients along the crucible, and these were eliminated. All the pressure-temperature data used in the calculations were obtained on the mass spectrometer, so that the instrumental constants cancel out. The average heat of formation of ZrB_2, assuming $\Delta S = \Delta C_P = 0$, was near −59 kcal/mole. Large-grained specimens of polycrystalline TiC, which are completely brittle at room temperature, exhibited remarkable ductility in long-term creep tests in the range 1600 to 1700°C. One specimen, pulled to fracture, necked to over 90% reduction in area just like a very ductile metal. Stresses of the order of 5000 psi were required to produce creep at a measurable rate near 1600°C. Progress was made on the design and construction of apparatus for zone-refining tungsten and for testing it in tension at high temperature without contamination. The thermal expansion of TiC was measured up to 2080°C, at which temperature the expansion is 1.80%. Measurements of galvanomagnetic properties were made on $NbC_{0.5}N_{0.5}$, ZrB_2, and HfB_2. The Hall coefficient of $NbC_{0.5}N_{0.5}$ was found to be smaller than that of NbC, in accord with the view that nitrogen contributes more electrons than does carbon to the energy bands. Considerable effort was devoted to the preparation of solid solutions between carbides. It was demonstrated that solid solutions are formed much more readily from stoichiometric mixtures of carbon with powders of the metals desired in the solution (or their hydrides or oxides) than from mixtures of the carbides themselves. The homogenizing of carbide solutions by various heat treatments was observed by following the resulting reduction in x-ray diffraction line broadening. The resistivities of the hot-pressed test specimens produced are routinely determined as are the densities of these samples. Extrapolations of these resistivity values to theoretical density give results in agreement with published data for TaC, TaB_2, HfB_2, and ZrB_2. However, they are lower than the literature values for NbC and HfC, probably indicating better purities for our materials. A critical examination and refinement of the technique for determination of free carbon in carbides led to greatly improved accuracy for this determination. (auth)

417 (NP-12162) PREPARATION AND EVALUATION OF HIGH PURITY BERYLLIUM. Quarterly Progress Report, April 2, 1962 to July 1, 1962. G. E. Spangler, M. Herman, E. J. Arndt, D. B. Hoover, V. V. Damiano, and G. S. Tint (Franklin Inst. Labs. for Research and Development, Philadelphia). Contract NOw 62-0536-d. 46p. (Q-B1933-3)

Production of high-purity beryllium and studies of its deformation and fracture characteristics are discussed. Topics covered include: zone refining, mechanical testing, polycrystalline zone-melted beryllium, electron transmission microscopy, eddy-current measurements of resistivity, and self-diffusion in beryllium. (M.C.G.)

418 (NP-12164) URANIUM IN NON-FERROUS METALS. Mines Branch Research Report R-97. R. Thomson and J. O. Edwards (Canada. Dept. of Mines and Technical Surveys. Mines Branch). July 1962. 47p.

The use of uranium metal in non-ferrous metallurgical practice is discussed with reference to its alloying behavior and chemical activity, and it is suggested that the more promising applications are in the treatment of molten metals to combine with impurities. Work along these lines is described for copper, zinc, magnesium, aluminum, and nickel alloys. It is shown that a copper–uranium master alloy (25% U) successfully deoxidizes molten copper without detriment to the electrical or mechanical properties of the product at residual uranium levels of up to 0.8 wt %. Additions of uranium to α brass in amounts greater than the lead impurity content were found to remove the deleterious effect of lead on hot-workability. Similar deoxidizing and malleableizing effects were found with uranium additions to nickel. It is thought that uranium forms stable intermetallic compounds with many impurity elements, thus a significant malleableizing effect can be expected in the presence of other elements besides lead. The effects of uranium on hot dip galvanizing and on grain refinement in magnesium and aluminum alloys were evaluated, but no beneficial effects were noted. (auth)

419 (NP-12170) DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. Patricia B. Plate, comp. (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Sept. 1962. Contract AF33(616)-7747. 70p.

A listing of selected documents and journal articles in an abstracted form are presented under the following topics: high-strength alloys, light metals, nonmetals, refractory metals, and miscellaneous. Author and subject indexes are included. (M.C.G.)

420 (NP-12174) REFRACTORY INTERMETALLIC COMPOUNDS. Final Report. (Research Chemicals. Div. of Nuclear Corp. of America, Phoenix, Ariz.). Feb. 1962. Contract NOw 61-0257c. 77p. (RC-195)

An investigation of intermetallic refractory compounds was carried out. Alloy series were designed for screening materials which would show promise of elevated temperature utilization. Parameters used for evaluation included melting points, oxidation resistance, strength-to-weight ratios at elevated temperatures, and ductility indications at normal ambient temperatures. A Hf-B intermetallic alloy of interest was produced along with a phosphide surface coating for decreasing rate of corrosion. X-ray and metallographic methods were used for compound verification. (auth)

421 (TID-17007) RECRYSTALLIZATION AND SINTERING OF OXIDES. Progress Report, September 1, 1961–August 31, 1962. Ivan B. Cutler (Utah. Univ., Salt Lake City. Inst. of Rate Processes). Contract AT(11-1)-1122. 117p.

Progress was made in the investigation of the sintering of aluminum oxide, the effect of small amounts of impurities on both the sintering and grain growth of alumina, the diffusion of wustite into periclase, and the electrical conductivity and thermoelectric power of $Fe_{1-x}O$–MgO solid solutions. The effects of small quantities of TiO_2 on the sintering of alumina were previously observed to increase the initial sintering rate. Initial results concerning titania additions to Al indicated that a change from grain boundary to bulk diffusion is responsible for the increased rate in the alumina investigated. The increased sintering rate was observed only between certain concentration limits which changed with the particle size of the alumina investigated. The investigation of the diffusion of wustite (FeO) into periclase (MgO) single crystals was successful. Iron oxide diffuses into periclase with layer as well as an exponential dependence on the concentration of vacancies in the solid solution. The entropy of activation was markedly influenced by the vacancy concentration. Grain growth studies using high-purity alumina were also successful. Contamination by the furnace atmosphere, probably with Na_2O, appears to be one cause of exaggerated grain growth, as observed previously. When the furnace atmosphere is "clean", no exaggerated grain growth was observed, even though the grain diameter was about ten times that for which exaggerated grain growth occurs in most commercial aluminas. When exaggerated grain growth did occur in the high-purity alumina, the grains were up to one cm in diameter. The grain diameter of regular growth was observed to increase with about the cube root of time. The electrical conductivity and thermoelectric power of $Fe_{1-x}O$–MgO solid solutions were measured as functions of temperature, MgO concentration, and Fe^{3+}/Fe^{2+} ratio. The electrical conductivity increased as the percentage of $Fe_{1-x}O$ increased in the solid solutions. A time dependence in which the conductivity decreased with time was observed at 350 to 490°C. Thermoelectric power measurements revealed that $Fe_{1-x}O$–MgO solid solutions are p-type semiconductors. (auth)

422 (TID-17011) NOBLE GAS SOLUBILITY AND DIFFUSION IN UO_2. Summary Report, June 30, 1961–August 31, 1962. S. Hasko and S. T. DeLuca (National Bureau of Standards, Washington, D. C.). Contract AT (49-2)-1165. 19p.

Activities in an investigation of He solubility and diffusion in single crystal UO_2 are reported. Background information is given including a tabulation of previous work. An examination of the theory of He solubility in UO_2 is included. Work was initiated during the period on characterization of UO_2 crystals obtained from Hanford and Belgium. In these experiments, He is introduced into the UO_2, and the total amount absorbed by the UO_2 is determined by dissolving samples in HNO_3 and measuring the released He. (J.R.D.)

423 (AEC-tr-5032) BORON, ITS COMPOUNDS AND ALLOYS. G. V. Samsonov, L. Ya. Markovskii, A. F. Zhigach, and M. G. Valyashko. Translation of "Boron, ego Soedineniya i Splavy" (a Publication of the Publishing House of the Academy of Sciences of the Ukrainian S.S.R., Kiev, 1960). 638p.

Chemical and metallurgical studies of boron and its compounds are discussed. Topics covered include: the bases of the geochemistry of boron; boron raw materials and their processing; the production, properties, and uses of elementary boron, boranes, and boron halides; and the properties, methods of production, metallography, and crystallochemistry of alloys of boron with metals and non-metals. A description is given of the known systems in which boron participates. The problems of the use of alloys of boron in the production of heat-resistant alloys are outlined. Radiotechnology, electrotechnology, machine construction, metallurgy, and chemistry are discussed. (M.C.G.)

424 MICROFRACTOGRAPHIC OBSERVATIONS OF THE SINTERED URANIUM DIOXIDE. A. Bassi (Laboratori CISE, Milan), G. Camona, G. Dassù, and G. Piazzesi. Energia Nucl. (Milan), 9: 513-28(Sept. 1962). (In Italian)

Because the observation of the porosities present in the material and their evolution during the different experiments is essential in the study of UO_2 sintering, a tech-

nique was perfected for the observation of fracture surfaces by the electron microscope. This technique proved to be useful for obtaining exact and reproducible information on the material. The results obtained are given, together with the relative conclusions. (auth)

425 NOW YOU CAN USE ZIRCONIUM FOR CHEMICAL PLANT SERVICE. John H. Schemel (Carborundum Metals Co., Akron, N. Y.). Mater. Protect., 1: No. 7, 20-6(July 1962).

A discussion is given of zirconium's resistance to strong acids and alkalis which make it useful in fabricating equipment for the chemical process industry. The several grades and alloys available are outlined, and the advantages of each grade's resistance to specific media are shown. New alloys being developed are described. It is emphasized that a zirconium alloy or grade selected for use in chemical process equipment should be tested in the process medium. Welding problems are discussed, and several applications of zirconium are presented. A bibliography on zirconium and corrosion problems related to the metal is given. (auth)

426 MATERIALS IN DESIGN ENGINEERING. MATERIALS SELECTOR ISSUE. Materials in Design Eng., 56: 1-570(Mid-Oct. 1962).

The latest available data are presented on engineering materials, forms, finishes, and joining and fastening methods. The materials covered include metals, plastics, rubber, coatings, etc. New developments are reviewed. A directory of the leading suppliers of engineering materials, finishes, forms, and shapes is included. (D.L.C.)

427 BERYLLIUM—A SPACE-AGE METAL. Thomas J. Hughel (General Motors Corp., Warren, Mich.). Metals Eng. Quart., 2: No. 2, 42-51(May 1962).

The availability and price trends of beryllium are discussed, as are the special properties which make it useful in rockets and space vehicles. Present technical impediments to the use of beryllium are reviewed, together with steps being taken to overcome them, as in the application to inertial guidance devices described. (auth)

428 EFFECTS OF IMPURITIES AND SELF-IRRADIATION ON THE ELECTRICAL RESISTIVITY OF ALPHA-PHASE PLUTONIUM BELOW 300°K. C. E. Olsen and R. O. Elliott (Los Alamos Scientific Lab., N. Mex.). Phys. and Chem. Solids, 23: 1225-40(Sept. 1962).

Electrical resistivities were measured as a function of temperature below 300°K on six α-phase plutonium specimens, each made from a different purity of plutonium metal. The observed resistivity behaviors are discussed and correlated with impurity contents and with other physical properties of plutonium. Possible electrical conduction mechanisms in α-phase plutonium are discussed. In addition, measurements were made showing that self-irradiation from the α-activity in plutonium produces damage at low temperatures. The resistivity was found to increase linearly with time at constant temperatures and annealing of stored damage was also studied. The radiation damage behavior of α-phase plutonium is discussed. (auth)

429 EFFECTS OF SELF-INDUCED RADIATION DAMAGE ON THE LOW TEMPERATURE HEAT CAPACITY OF A SPECIMEN OF ELECTRO-REFINED HIGH PURITY PLUTONIUM. T. A. Sandenaw (Los Alamos Scientific Lab., N. Mex.). Phys. and Chem. Solids, 23: 1241-8(Sept. 1962).

The effects of self-induced radiation damage on the heat capacity of a specimen of high purity plutonium metal when held at the temperature of boiling liquid hydrogen for a day and also for a week are shown. Heat capacity versus temperature curves obtained after rapid quenching to the temperature of boiling liquid helium are presented for comparison. An equation is given relating heat capacity to temperature in the range 98 to 300°K. Calculated values of thermodynamic properties are compared with previously reported values. Effects of age of specimen and impurity content are discussed, as well as the possibility of a low temperature crystallographic modification. (auth)

430 AXIALLY SYMMETRIC MODEL FOR LATTICE DYNAMICS OF METALS WITH APPLICATION TO Cu, Al, AND ZrH_2. G. W. Lehman, T. Wolfram, and R. E. De Wames (North American Aviation Science Center, Canoga Park, Calif.). Phys. Rev., 128: 1593-9(Nov. 15, 1962).

A lattice dynamics model (A-S model) is proposed for metals which assumes that the restoring forces between the ions have the character of bond stretching and axially symmetric bond bending. It is shown that this type of restoring force is derivable from a sum of spherically symmetrical two-body potentials, $v(R_{ij})$, taken over all (i,j) pairs of lattice sites separated by a distance R_{ij}. The dynamical matrix for a face-centered cubic lattice is worked out for the first three neighbor shells of atoms. The dispersion curves for aluminum and copper are derived from the elastic constant and thermal diffuse x-ray data. The A-S force constants or Cu and Al fall off rapidly with distance and give dispersion curves which are at least as good as those derived from the third-neighbor general tensor force model. Particularly noteworthy is the fact that Walker's tensor force constants for Al are nearly axially symmetric. However, Jacobsen's tensor force constants for Cu are not axially symmetric. Contrary to this observation, it is found that White's force constants derived by using Feynman's theorem are nearly axially symmetric. The A-S model is also applied to ZrH_2 which has a tetragonally deformed fluorite structure. It is shown that the six optical branches are flat to within 3% over the entire Brillouin zone and that the hydrogen-hydrogen interactions are very weak compared to the hydrogen-zirconium interactions. The dynamical matrix for the acoustic spectrum is derived. (auth)

431 PROPERTIES OF REACTOR MATERIALS AND THE EFFECTS OF RADIATION DAMAGE. Proceedings of the International Conference held at Berkeley Castle, Gloucestershire, England from 30th May to 2nd June, 1961. D. J. Littler, ed. London, Butterworths, 1962. 572p. $21.00.

Forty-nine papers, one summary of a paper, and discussions of the papers are included under the following main headings: measurement of damage flux and neutron spectra within a reactor system; displacement theory of damage; observation of defects; mechanical properties; corrosion; growth in solids caused by thermal cycling and irradiation; and swelling of reactor materials. Forty-eight papers are covered by separate abstracts. One was previously abstracted for NSA. (A.G.W.)

432 RADIATION EFFECTS AND POINT IMPERFECTIONS IN METALS. F. Seitz (Univ. of Illinois, Urbana). p.3-4 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

The energy of vacancy formation in metals can be evaluated by comparison of increase in volume of the metal with its change in lattice parameter at temperatures up to the melting point or by quenching for high temperatures and studying the rate of change of electrical resistance on subsequent annealing. Details of the annealing kinetics of vacancies and interstitials produced by irradiation have

been studied by irradiating at very low temperatures and following the recovery over a wide temperature range. For Cu ratios have been established between stored energy and electrical resistivity and between stored energy and volume expansion after very low temperature bombardment. Only a summary of this lecture is included. (A.G.W.)

433 FRACTURE. A. H. Cottrell (Cambridge Univ., Eng.). p.5-14 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Two separate conditions have to be satisfied before a material can break: (1) the thermodynamics has to be favorable, and (2) there must be a possible mechanism of growth of the fracture. Basic processes involved in the following types of fractures are discussed: thermal and chemical fractures; fracture by plastic shear; ductile fractures below the general yield stress; brittle fracture nucleated by slip and twinning; and brittle fracture at low temperatures in relation to local and general yielding. (A.G.W.)

434 MATERIALS PROBLEMS OF NUCLEAR POWER—HISTORICAL. L. Rotherham (Central Electricity Generating Board, London). p.15-28 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Wartime developments in nuclear energy in the United States and the postwar development of gas-cooled reactors in Great Britain are surveyed with emphasis on materials problems and their influence on major engineering decisions. The main problems in the next ten years are expected to concentrate on graphite, fuel elements, and pressure vessel steels. The discussion of these problems includes a brief description of fuel elements for the Calder Hall reactors. (A.G.W.)

435 THE CALCULATION OF DAMAGE FLUX FOR THE WIGNER EFFECT. J. P. Genthon (Commissariat à l'Énergie Atomique, Saclay, France). p.31-56 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

A means of determining fluxes of fast and intermediate pile neutrons is established. Various types of calculations are tried according to the types of reactor in question. A fairly simple calculation confirmed by measurements is most satisfactory. Results are given for a heterogeneous reactor (generally heavy water or graphite reactor) and for a light water reactor considered as homogeneous. The importance of fast and intermediate fluxes as far as the Wigner effect is concerned is compared. (A.G.W.)

436 INVESTIGATION OF DIAMOND AND SILICON CARBIDE AS INDICATORS OF IRRADIATION CONDITIONS. N. F. Pravdyuk, V. A. Nikolaenko, V. I. Karpuchin, and V. N. Kuznetsov (Nuclear Energy Inst., Academy of Sciences, Moscow). p.57-62 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

The x-ray examination of the lattice expansions of diamond and silicon carbide irradiated in an RFT reactor with fluxes from 10^{19} to 7×10^{20} thermal neutrons/cm^2 is described. A discussion follows of experiments conducted with a view to studying the effect of irradiation on these substances when specimens are positioned at different places in the reactor. Specimens were annealed in the temperature range from 120 to 900°C, as a result of which it was established that the removal of radiation damage (lattice expansion) is a continuous process. Radiation temperatures varied between 120 and 420°C. It was established that diamond and silicon carbide could be used as indicators of irradiation conditions, that is, irradiation temperature and neutron flux causing radiation damage in the material. (auth)

437 THE PRODUCTION OF ATOMIC DISPLACEMENTS NEAR THRESHOLD IN Fe AND Cu. PART 1. THE THRESHOLD DETERMINATION IN POLYCRYSTALS. A. Lucasson (Université, Paris), P. Lucasson, and R. M. Walker. PART 2. PRELIMINARY RESULTS ON MONOCRYSTALS IRRADIATION. Y. Cusson (California Inst. of Tech., Pasadena), P. Lucasson, and R. M. Walker. p.83-94 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

In Part I recent experimental results for the production of damage by electrons of different energies in the neighborhood of 1 Mev are compared with calculated curves based on different assumptions concerning the nature of the atom displacement process. Cu and Fe are considered. In Part II some preliminary new results on single crystals are presented briefly. (auth)

438 THE ROLE OF DYNAMIC CROWDIONS IN THE PROCESS OF RADIATION DAMAGE IN FACE-CENTERED CUBIC METALS. Ryukiti R. Hasiguti (Tokyo Univ.). p.95-7 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

The trapping process of dynamic crowdions by impurity atoms was analyzed, and it was found that dynamic crowdions travel about a hundred atomic distances in average before they are trapped. This mean travel length is quite reasonable. The fact that a reasonable travel length of dynamic crowdions was obtained in the analysis means that the dynamic crowdions do really exist and are playing an important role in the process of atomic displacement in radiation damage. (auth)

439 THE ENERGY SPECTRUM OF SPUTTERED ATOMS FROM Au UNDER 43 kev Xe^+ ION BOMBARDMENT. M. W. Thompson, R. S. Nelson, and B. W. Farmery (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.98-100 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

The velocity distribution of a beam of sputtered gold atoms from a radioactive gold target under 43 kev Xe^+ bombardment was analyzed by a time of flight method using twin rotating discs. In the range from 0.03 to 0.05 ev a spectrum of energies was observed having a peak at 0.15 ev. An interpretation is offered in terms of evaporation from thermal spikes produced by the unfocused component of the primary recoil energy. (auth)

440 SINGLE VACANCY AND DIVACANCY ELECTRON BOMBARDMENT CROSS-SECTIONS IN COPPER. A. Sosin and J. A. Brinkman (Atomics International, Canoga Park, Calif.). p.101-7 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Estimates have been made of the cross-section for production of single vacancies and divacancies in copper by high-energy electron irradiation on the basis of certain simple assumptions. These assumptions are: (1) The threshold displacement energy, T_d, is sharp; or more precisely, the probability, W, that an atom is displaced, when plotted as a function of its initial kinetic energy, is zero below T_d and equal to a constant which is greater than zero and less than or equal to unity above T_d. (2) In considering the fate of each of the two neighboring atoms which must be displaced to produce a divacancy, the values of both T_d and

W are unchanged from those for production of a single vacancy. (3) The collision of each primary knock-on with its first struck atom can be treated by the hard-sphere approximation using a Born-Mayer atomic interaction potential function. (4) A divacancy is produced in a fraction, W, of displacement events which, after the first collision of a primary knock-on, leave both it and the struck atom with kinetic energies in excess of T_d. The cross-section for divacancy production σ_{II}^{D}, is found to rise from zero, at the electron energy at which the maximum possible energy transfer to lattice atoms is $2T_d$, to a value of about 18 per cent of the quantity $W\sigma_I^D$, at an electron energy of 2.5 Mev, where σ_I^D represents the cross-section for production of single vacancies. The exact value depends somewhat on the choice of parameters used in the Born-Mayer interaction potential energy function. Nine calculations have been performed covering three different Born-Mayer functions and three different assumed values for T_d. (auth)

441 THE APPLICATION OF FIELD ION MICROSCOPY TO THE STUDY OF RADIATION DAMAGE. D. G. Brandon, M. J. Southon, and M. Wald (Cambridge Univ., Eng.). p.113-19 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

A resolution of 2 or 3 Å makes field ion microscopy a suitable method for investigating radiation damage effects when the contrast or resolution of the electron microscope proves insufficient. Tungsten specimens were bombarded by 5-Mev α particles. A very low flux was used, and damage due to a single primary event was observed. A tentative interpretation of the damage is offered. (A.G.W.)

442 LATTICE DEFECTS IN GOLD AND PLATINUM PRODUCED BY LOW-ENERGY ION BOMBARDMENT. D. G. Brandon, P. B. Bowden, and A. J. Baker (Cambridge Univ., Eng.). p.120-6 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Thin films of Au and Pt were bombarded with low-energy argon ions at temperatures from –50°C to +100°C. By electron microscopy, dislocation loops and small regions of lattice strain were observed after doses of 10^{17} to 10^{18} ions/cm^2. The efficiency of point defect production was found to be about 5×10^{-4} defects per ion, varying over an order of magnitude with both orientation and temperature. Possible mechanisms of point defect production are discussed. (A.G.W.)

443 EVIDENCE FOR A DAMAGE RATE DEPENDENCE IN THE FORMATION OF DEFECT CLUSTERS IN ALUMINIUM. C. J. Beevers and R. S. Nelson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.127-31 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962. (AERE-R-3760)

Thin aluminum foils ~2000 Å thick have been irradiated by 85 kev ions of H and He, at 40°C to doses up to 10^{18} ions cm^{-2}. Subsequent examination of these foils in the electron microscope revealed defect clusters in the form of spots and dislocation loops to a density of $\sim 5 \times 10^5$ cm^{-3}. These results are compared with neutron-irradiated aluminum, where relatively few displaced atoms have been observed to remain in the form of clusters. (auth)

444 DARK FIELD ELECTRON MICROSCOPY APPLIED TO RADIATION DAMAGE IN GRAPHITE. W. Bollmann (Battelle Memorial Inst., Geneva). p.132-43 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Examples are given to show that, by dark field electron microscopy and comparison of pictures from different diffractions, much information on lattice defects such as those produced by irradiation may become accessible in spite of practical difficulties. The discussion is concentrated on graphite, and the contrast is interpreted by the kinematical theory of electron diffraction. (A.G.W.)

445 ELECTRON MICROSCOPE STUDIES OF RADIATION DAMAGE IN GRAPHITE. G. K. Williamson (Berkeley Nuclear Labs., Gloucestershire, Eng.). p.144-8 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Interpretation of electron microscope observations of irradiated graphite is discussed. Mobility of interstitials and size distribution of interstitial clusters are considered. Very approximate activation energies for formation and movement of vacancies are deduced. (A.G.W.)

446 THE STUDY OF RADIATION DAMAGE BY ION BOMBARDMENT OF THIN FILMS. J. W. Menter, D. W. Pashley, and A. E. B. Presland (Tube Investments Research Labs., Saffron Walden, Essex, Eng.). p.149-59 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

In an attempt to find a method of studying some aspects of radiation damage with more control over the experimental situation than is common in experiments involving reactor irradiation, single crystal films of Au were irradiated by ions emitted from the tungsten filament of an electron microscope. Observations on specimens irradiated under various conditions are described. It is concluded that useful information can be obtained by this method. Possible future improvements are suggested. (A.G.W.)

447 EXAMINATION OF URANIUM FISSION WITH AN ELECTRON MICROSCOPE. N. F. Pravdyuk and V. M. Golyanov (Nuclear Energy Inst., Academy of Sciences, Moscow). p.160-75 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

A method has been developed for obtaining high resolution replicas. Amorphous layers of U, Ir, and Al were procured with background structures under 10 Å; this gave a limit of resolution of ~10 Å. With the aid of these layers, a study was made of the interaction between U^{235} fission fragments and certain materials. (auth)

448 CORRELATED ELECTRICAL RESISTIVITY AND ELECTRON MICROSCOPE MEASUREMENTS IN F.C.C. METALS. R. M. J. Cotterill (Cambridge Univ., Eng.). p.176-85 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

The electrical resistivity of stacking faults and vacancies in Au and dislocations in Al was determined. Annealing characteristics of Au quenched from 1000°C and 750°C were studied. The effects of impurities and of multiple quenching on the defect structures in Al, Au, and Cu are discussed. (A.G.W.)

449 THE EFFECT OF IRRADIATION ON STRAIN IN STRESSED GRAPHITE. G. M. Jenkins (Berkeley Nuclear Labs., Gloucestershire, Eng.). p.201-3 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Cylindrical specimens of graphite under compressive stress were irradiated in the Herald reactor, Aldermaston. Stress-strain history of two specimens is shown schemati-

cally. A tentative explanation for the observed results is offered. (A.G.W.)

450 FURTHER STUDIES OF SMALL ANGLE X-RAY SCATTERING BY PILE-IRRADIATED GRAPHITE. W. T. Eeles and J. M. Sutcliffe (Berkeley Nuclear Labs., Gloucestershire, Eng.). p.204-7 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Small-angle x-ray scattering by graphite was observed down to $2\theta = 0.5°$ with a pulse-height analyzer to achieve monochromatization. Curves are shown for unirradiated graphite, graphite irradiated at 150°C and 300°C, and for an irradiated specimen which was annealed at successively higher temperatures up to 1500°C. Previous observations were largely confirmed. Possible explanations of the results are suggested. (A.G.W.)

451 ENERGY STORED BY IRRADIATED GRAPHITE—VARIATION OF THE ENERGY AS A FUNCTION OF SUCCESSIVE ANNEALINGS. M. Quetier and J. Rappeneau (Commissariat à l'Énergie Atomique, Saclay, France). p.208-18 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Under neutron bombardment at relatively low irradiation temperatures (40 to 150°C), graphite rapidly stores away energy. The graphite moderators of piles operating at these temperatures (for example the Marcoule pile G1) must be annealed fairly frequently. For this the accumulation of energy by the graphite as a function of time must be studied, and methods have been developed for measuring the energy: (a) Annealing at constant temperature, which gives an overall value H_{20}^{400} cal g^{-1} of the energy released by graphite irradiated between room temperature and 400°C; (b) differential thermal analysis, which gives the enthalpy variation $dH/d\theta$ (cal $g^{-1}°C^{-1}$) as a function of the temperature θ, the latter varying between room temperature and 800°C. Following a brief outline of these measurement methods, it is shown that the energy released by the irradiated graphite increases linearly as a function of dose at a given irradiation temperature. These results were obtained before the first annealing of the G1 moderator. The effect of annealing was established by comparing the overall energies H_{20}^{400} or the energy spectra measured before and after annealing of the moderator. Only slight residual energy is left in the graphite after annealing, but healing of the damage produced in the graphite as an effect of radiation is far from complete. The result is that before the 2nd and 3rd annealings of the G1 moderator an "early effect" was observed: the energy accumulated very rapidly at the beginning of the reirradiation of the annealed graphite, whatever the irradiation temperature. This effect disappears at relatively low irradiation doses ($\approx 0.25 \times 10^{20}$ n cm^{-2}), after which, at a given irradiation temperature, the energy once more increases linearly with the dose at a rate close to that observed before the first annealing. Moreover, with successive annealings the energy stored away by the graphite undergoes an evolution which is shown up by progressive modification of the energy spectrum. (auth)

452 THE ELECTRONIC STRUCTURE OF DEFECTS—OPTICAL METHODS. C. D. Clark and E. W. J. Mitchell (Univ. of Reading, Berks, Eng.). p.219-225 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Optical techniques that may be used to obtain information about the electronic structure of centers in cubic crystals are summarized. One of these—polarization of luminescence—was used to study the 5032 Å center formed in some diamonds by heat treatment after irradiation. The center was found to have basically a $\pi[110]$ symmetry. Depolarization was thought to arise from vibrational effects. Two possible models are indicated. (A.G.W.)

453 CONTRIBUTION OF CRYSTALLOGRAPHIC ANALYSIS USING X-RAYS TO THE STUDY OF IRRADIATION DEFECTS IN GRAPHITE. M. Pluchery (Centre d'Etudes Nucléaires, Grenoble, France). p.226-30 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

An apparatus is described which can be used for x-ray crystallographic study of graphite specimens irradiated at liquid nitrogen temperatures at the same temperature without intermediate heating. Details of measurements actually made will be published later. Possible future development of the method is discussed. (A.G.W.)

454 STRAIN RELAXATION BY IRRADIATION. R. V. Hesketh (Berkeley Nuclear Labs., Gloucestershire, Eng.). p.231-2 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Tentative conclusions are offered concerning the mechanism of strain relaxation and the accompanying change in density during irradiation of Fe, Cu, stainless steel, and Fe, Ni, and Co alloys. (A.G.W.)

455 THE RELAXATION OF ELASTIC STRESSES UNDER NEUTRON IRRADIATION. K. P. Dubrovin, S. T. Konobeyevskii, B. M. Levitskii, L. D. Panteleyev, P. A. Platonov, and N. F. Pravdyuk (Nuclear Energy Inst., Academy of Sciences, Moscow). p.233-44 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Relaxation of both fissile and nonfissile materials during irradiation was studied by two methods: (1) measuring the deflection of an elastically stressed flat spring, and (2) measuring and analyzing the form of the x-ray lines from specimens which were first cold worked and then irradiated. There was rapid stress relaxation in almost all materials investigated; the greatest effect was seen in the fissile materials. Results are tabulated for U, U-Mo alloys, Ni, Mo, Pt, Zr, W, and bronze. A tendency for the flat springs to revert to their original form after they had undergone relaxation was observed. The rate of this reversion varied with the radiation dose previously applied. (A.G.W.)

456 APPLICATION OF MAGNETIC MEASUREMENTS TO THE STUDY OF IRRADIATION EFFECTS. D. Dautreppe, J. Pauleve, P. Moser, and P. Brissonneau (Centre d'Etudes Nucléaires, Grenoble, France). p.245-50 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

The significance of magnetic measurements in the study of irradiation effects is shown by use of two magnetic phenomena: (1) magnetic after-effects of diffusion, and (2) the orientation superstructures. After-effect bands were found in Fe irradiated with neutrons at 30°C and 77.5°K. The bands were displaced by annealing. It was also found that an orientation superstructure that cannot be created by a thermal treatment within any reasonable time except at high temperatures was created by neutron irradiation at ordinary temperatures. The rate of formation of the superstructure was dependent on the irradiation temperature. (A.G.W.)

457 ON THE THEORY OF THE EFFECT OF IRRADIATION ON SOME PROPERTIES OF GRAPHITE. V. M. Agranovich and L. P. Semenov (Nuclear Energy Inst., Academy of Sciences, Moscow). p.251-58 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Changes in the characteristics of graphite during irradiation are due to the disruption of the crystal lattice. The compressibility and bond energy of an ideal graphite monocrystal and the variation of the lattice parameter and the internal energy of a graphite crystal containing imperfections (Frenkel defects) are calculated. Results of the calculation are compared with experimental results. (A.G.W.)

458 RECENT WORK IN STUTTGART ON RADIATION DAMAGE AND THE PROPERTIES OF POINT DEFECTS IN METALS. A. Seeger and J. Diehl (Max-Planck-Institut für Metallforschung, Stuttgart). p.269-75 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

A theory that "depleted zones" are formed in close-packed metals such as Cu during irradiation is compared with experimental data on radiation hardening, critical shear stress, and changes in slip-line pattern. Interpretation of the annealing of radiation damage at low and moderate temperatures in terms of the migration of point defects is discussed. (A.G.W.)

459 MECHANICAL PROPERTIES OF IRRADIATED GRAPHITE: MODIFICATION OF THE HARDNESS AFTER RADIATION AND ANNEALING. G. Jouquet and J. Rappeneau (Commissariat à l'Énergie Atomique, Saclay, France). p.276-86 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

The investigation of radiation damage in graphite often necessitates the taking of samples from the pile in the form of small cylinders cut from the internal walls of the channels (borings). These samples must be taken in such a way as not to cause any change in their state by heating. The sampling conditions can be determined by studying the changes in the graphite hardness under the effects of irradiation. The determination of the hardness of the graphite by means of the pressure of a metal sphere leads to observations which are not in accordance with those made on conventional materials, because of the complex texture of the graphite. The hardness has thus been defined as the ratio of the applied force to the maximum area of the impression produced. A large number of measurements are necessary due to the heterogeneity of the graphite. The study of the hardness h_0 of the non-irradiated graphite made it possible to establish the relationship between hardness and apparent density, as well as the influence of anisotropy. Under the effects of irradiation the hardening can be expressed as a linear function of the dose for a given irradiation temperature. These results were obtained for temperatures between 50 and 150°C and for doses of up to 1.2×10^{20} n cm^{-2}. The variation in the increase of hardening with increasing dose was determined as a function of the irradiation temperature. The recovery of the hardening by thermal annealing has been studied. The amount of recovery depends on the annealing temperature, and on the amount of damage produced by the irradiation. The increase in the recovery factor per °C, as a function of the annealing temperature, passes through a maximum at about 250°C. The samples studied regained approximately the hardness of non-irradiated graphite after annealing at 900°C. (auth)

460 THE EFFECT OF FAST NEUTRONS ON CERTAIN PROPERTIES OF IRON–CARBON ALLOYS. Sh. Sh. Ibragimov (Physical Energy Inst., Obninsk, USSR). p.287-92 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Specimens of Fe and carbon steels (containing 0.16 to 1.05 wt % C) were irradiated with fast neutrons at 320 to 380°C. The irradiation increased the hardness and coercive force of the specimens but lowered their electrical resistivity. The changes in properties were apparently related to the C content of the Fe. Annealing curves showed evidence that the changes in properties were connected not only with radiation defects but also with a change in the initial structure of the material. (A.G.W.)

461 INFLUENCE OF NEUTRON IRRADIATION ON THE FATIGUE PROPERTIES OF MAGNESIUM AS DETERMINED BY INTERNAL FRICTION MEASUREMENTS. N. F. Pravdyuk, Yu. I. Pokrovskii, and V. I. Vikhrov (Nuclear Energy Inst., Academy of Sciences, Moscow). p.293-301 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

The influence of neutron irradiation on the endurance limit of annealed magnesium has been investigated. The changes which occurred during all stages of fatigue were determined by internal friction measurements carried out at 200-300 cycles sec^{-1} after periodically interrupting the test. A peak in the internal friction-alternating stress curve suggests the initiation of a fatigue crack. (auth)

462 RADIATION DAMAGE, BRITTLE FRACTURE AND STRAIN AGEING IN STEEL. L. P. Trudeau (International Nickel Co. of Canada Ltd., Toronto). p.317-19 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Brittle fracture and strain aging in neutron-irradiated steel are discussed in relation to two tentative assumptions: (1) that a reduced density displacement spike of the order of 10 Å diameter is the basic hardening mechanism, and (2) that this heated region, possibly about an order of magnitude greater in diameter than the displacement spike, can give rise to metallurgical changes and result in secondary effects. Some proposals for development of alloys for use in pressure vessels subjected to a neutron-irradiation environment are suggested. (A.G.W.)

463 THE ROLE OF TWINNING IN THE FRACTURE OF BODY-CENTRED CUBIC METALS. D. Hull (Univ. of Liverpool). p.320-34 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

The experimental evidence for mechanical twinning in body-centered cubic metals is reviewed. After a summary of the essential features of mechanical twins in these metals, an account is given of the ways in which twinning contributes to the initiation and propagation of cleavage fracture. (auth)

464 SOME STUDIES OF GRAIN-BOUNDARY SLIDING. R. C. Gifkins (Commonwealth Scientific and Industrial Research Organization, Melbourne). p.335-42 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Intergranular fracture during creep often appears to develop from grain-boundary cavities, which are probably nucleated and may grow through the operation of grain-boundary sliding. A program of investigation into the mechanism of both sliding and cavitation is outlined and some preliminary results relating to sliding are given. Some earlier experiments with lead bicrystals are summarized. Measurements of sliding with fine-grained lead-thallium alloys at various stresses and also the effect of varying the grain size are given. These suggest how to reconcile previous disagreement about the contribution to the overall extension made by sliding measured on the surface and in the interior of the specimen. (auth)

465 THE EFFECT OF NEUTRON IRRADIATION ON THE PROPERTIES OF STRUCTURAL MATERIALS. N. F. Pravdyuk, A. D. Amaev, P. A. Platonov, V. N. Kuznetsov,

and V. M. Golyanov (Nuclear Energy Inst., Academy of Sciences, Moscow). p.343-58 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Specimens of carbon and low-alloy steels, austenitic stainless steels, Zr, and some alloys of Zr were irradiated with fast neutrons at various temperatures ranging from 100 to 600°C. Mechanical properties were then tested; some of the tests were conducted at temperatures up to 300°C. Curves and tables show the results. Results of an electron microscope examination of the microstructure of an irradiated Zr-Nb-B alloy are shown. (A.G.W.)

466 CREEP-DEFORMATION OF A MAGNESIUM–ALUMINIUM ALLOY. J. E. Harris and P. G. Partridge (Berkeley Nuclear Labs., Gloucestershire, Eng.). p.359-65 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

The structural changes during creep-deformation of a magnesium/0.7 per cent aluminium/0.005 per cent beryllium alloy have been studied. Tests were carried out at 2 per cent/hour at 230°C. Under these conditions it was found that the specimens partially recrystallized and that rupture occurred by the linking of intergranular cavities. It is suggested that irregular grain-boundary migration not only results in recrystallization but may also play an important part in nucleating the cavities. (auth)

467 OXIDATION OF URANIUM. J. E. Antill (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.379-82 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

The mechanisms and future developments in the oxidation of uranium are discussed in relation to Calder Hall type reactors. The present theories for the oxidation of unalloyed uranium appear satisfactory on a qualitative basis but need a quantitative backing. The reactions of both carbon monoxide and carbon dioxide with the fuel are of importance in a reactor and while data are available for these reactions in the absence of irradiation little has yet been published on the effects of irradiation: calculations indicate that the activation of the gas is likely to be the most important factor. Coatings appear the only method by which the attack under reactor conditions may be reduced appreciably as alloying has given discouraging results. Slight improvements may, however, be obtained with minor alloy additions and by keeping the carbon content of the metal low. (auth)

468 SOME PROPERTIES OF SURFACE OXIDE FILMS ON METALS. J. S. Llewelyn Leach (Univ. of London). p.383-7 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Some metals oxidize slowly because of a more or less efficient kinetic barrier, which commonly takes the form of a surface layer of a reaction product through which the reactants and sometimes the products diffuse. In order to understand the factors that influence the rate of diffusion, the oxide layer was considered not only as an inert obstacle to ionic diffusion but as an electrolyte and semiconductor. It appears that, in addition to the oxide thickness and structure (which includes ionic defects), other factors of importance in the diffusion process are the electronic conductivity and, in the case of oxidation by water or steam, the hydrogen pick-up of the metal. It is suggested that alloying affects the oxidation rate because of the different properties of the mixed oxide layer; effect on corrosion of alloying U with Zr is used as an example. (A.G.W.)

469 GASEOUS CORROSION OF GRAPHITE. D. V. Ragone and L. R. Zumwalt (General Atomic Div., General Dynamics Corp., San Diego, Calif.). p.388-95 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

At high temperatures reactor graphite is corroded by small impurities such as oxygen and water vapor in the inert gas coolant. Not only does this corrosion lead to deterioration of the graphite, but also the gaseous products of the attack tend to lose their C in the lower-temperature portions of the reactor. Thermodynamic and kinetic aspects of the reactions involved are discussed. Irradiation increases the rate of attack. Reactivity varies widely with characteristics of the graphite used such as impurity content, pore size and distribution, crystallographic orientation, and degree of crystal perfection. (A.G.W.)

470 IRRADIATION GROWTH. S. N. Buckley (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.413-29 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962. (AERE-R-3674)

Existing experimental results on irradiation growth of U and previously proposed explanations of the growth are reviewed. Current experiments are described in which the rates of anisotropic growth in single crystals and polycrystalline α U were found to be identical and much higher for irradiations at –196°C than at +75°C. The rate was not affected by plastic deformation prior to irradiation. Anisotropic growth was also observed in Zn, Zr, Ti, and Cd crystals irradiated by recoiling fission fragments at –196°C, and in Zr and Ti at 75°C, but was not detected in Be, Mg, or cubic metals. Growth rates at –196°C decreased with decreasing atomic mass. In all cases elongation was in the basal plane. The dependence of growth rate on atomic mass points to a mechanism depending on the generation of widely separated groups of vacancies and interstitial atoms in displacement spikes. It is suggested that the temperature dependence of growth rates in U and the hexagonal metals, and its disappearance above self-diffusion temperatures, could be a manifestation of thermal annealing of the defect clusters. (57 references) (A.G.W.)

471 THE THERMAL CYCLING OF ZIRCONIUM. I. Aitchison, R. W. K. Honeycombe, and R. H. Johnson (Univ. of Sheffield, Yorkshire, Eng.). p.430-9 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Metallographic specimens of high-purity Zr were thermally cycled at rates of 10°C/min on a Unitron vacuum hot stage attached to a Reichert microscope. Experiments were done between room temperature and 800°C, room temperature and 600°C, and 400°C and 800°C. The main structural changes were observed during the cooling half of the cycle when grain boundary movement occurred around 720°C, twins were formed in the range 400 to 120°C, and slip occurred from 300°C to room temperature. In addition, dimensional changes were studied on rod specimens cycled under various conditions in the α range. Variables whose influence on dimensional stability were considered included temperature range, texture, and conditions of heating and cooling rate and holding time at temperature. (A.G.W.)

472 THERMAL CYCLING OF GRAPHITE. C. R. Tottle (Univ. of Manchester, Eng.). p.440-3 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Specimens of reactor grade A graphite all cut from one 6-in. cube were cycled from 50 to 200°C and from 100 to

250°C. Dimensional changes were measured. Results to date indicate that behavior varies with texture. A specimen (A) parallel to the extrusion direction shortened. A second specimen (B) perpendicular to the extrusion direction, but from the same face of the cube as A, shortened and also increased in apparent linear coefficient. A third specimen (C) perpendicular to A and B lengthened and slightly increased in apparent linear coefficient. (A.G.W.)

473 RADIATION DAMAGE TO BORON-CONTAINING CONTROL MATERIALS. A. N. Holden, E. W. Hoyt, S. V. Cummings, and D. L. Zimmerman (General Electric Co., Pleasanton, Calif.). p.457-74 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Data on damage to boron-containing materials subjected to irradiation are given for elemental boron; boron carbide; boron compounds of the type MB_2, MB_4, and MB_6; boron oxides; boron glasses; boron alloys; and boron compounds dispersed in metal matrices. These data include physical property damage, damage due to helium and the extent of helium release, dimensional changes, and x-ray and metallographic examination of the damage. General discussion on the fundamentals of damage to boron materials is given, drawing on these data on specific materials. Recommendations are given for the areas needing further research and understanding. (auth)

474 OBSERVATIONS ON URANIUM IRRADIATED IN THE α- AND SUBSEQUENTLY IN THE γ-PHASE AND ITS IMPLICATIONS IN ASSESSING VOLUME INCREASES IN IRRADIATED FISSILE MATERIAL. G. W. Greenwood (Berkeley Nuclear Labs., Gloucestershire, Eng.). p.475-7 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

A U bar was irradiated between 450 and 540°C for 19 days. Then, at one end of the bar, a small region of U became molten because of partial loss of coolant and remained so for 3 days until the bar was moved slightly into a position such that the temperature was below the melting point. Irradiation continued for 76 days. The temperature of the other end of the bar remained below 660°C. Metallographic examination showed that when the temperature was raised during irradiation the number of gas bubbles in the U was substantially reduced and the bubble size increased. The results suggest that a limiting feature in the operation of metallic fuels at high temperatures is the small but significant solubility of the fission gases. A value of this solubility calculated for the bubble spacing agrees with other estimates. Implications in the general assessment of volume increases in irradiated fissile material are discussed. (A.G.W.)

475 SOME OBSERVATIONS OF GAS BUBBLE FORMATION IN IRRADIATED BORON STEELS. E. Roberts (Berkeley Nuclear Labs., Gloucestershire, Eng.). p.478-82 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Specimens were taken from an irradiated control rod (4 wt % boron steel) from the center zone of a Calder reactor. B^{10} burnup varied from 2 to 11%. Specimens were annealed in vacuum between 800 and 1100°C for times of 2 hr to 10 days. Distribution and size of gas bubbles were found to vary with location (in relation to phase), burnup, annealing temperature, and annealing time. (A.G.W.)

476 THE CHARACTERISTICS OF VARIOUS METALLIC NUCLEAR FUELS AND THEIR BEHAVIOUR UNDER IRRADIATION. M. Englander and J. A. Stohr (Commissariat à l'Énergie Atomique, Saclay, France). p.483-504 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Mechanical and physical properties of the following materials being considered as nuclear fuels for French gas-cooled, graphite-moderated power reactors are tabulated: as-cast U, cast U treated, α-extruded U treated, crude U cast and treated, U-0.1% Cr treated, U-0.4% Al, U-0.5% Mo, U-1% Mo, U-1.5% Mo. Three fuel element designs are considered; for each design, shape and size, methods of fabricating, methods of canning, properties of the can and irradiation conditions are described. The resistance of each material to deformation under irradiation is discussed as a function of burnup and the design of the fuel element. It is concluded that U-1% Mo gives most dependable results, but that other materials may be valuable under certain conditions. (A.G.W.)

477 THE EFFECTS OF IRRADIATION ON URANIUM ALLOYS WITH SMALL MOLYBDENUM CONTENTS. J. P. Mustelier, H. Mikailoff, J. L. Ratier, D. Gondal, and J. Bloch (Commissariat à l'Énergie Atomique, Saclay, France). p.505-24 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Nineteen specimens of uranium–molybdenum alloys containing 1, 2, and 3 per cent molybdenum by weight were irradiated in a loop in the reactor EL3, between 410 and 500°C. The alloys had been homogenized in the γ-phase, quenched, and then annealed at temperatures between 450 and 600°C. The burn-up varied between 0.37 and 0.55 per cent. Density measurements indicate swelling of between 2 per cent at 410°C, and 57 per cent at 510°C. The temperatures quoted are those of the surrounding sodium; those of the sample are higher by an undetermined amount. Fracture surfaces examined by the electron microscope replica technique show the presence of a large number of gas bubbles, the volume of which corresponds roughly to the swelling produced. (auth)

478 SOME DENSITY CHANGES OBSERVED ON HEATING IRRADIATED URANIUM. T. K. Bierlein (General Electric Co., Richland, Wash.). p.525-6 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Disk specimens from clad rods that had been irradiated with high restraining pressures and/or low temperatures to 0.29 and 0.41% burnup, respectively, were declad and vacuum annealed at 400, 500, 600, 650, 700, and 880°C for times of 1 to 100 hr. Observed density changes and the ratio of % volume increase to % burnup are tabulated. (A.G.W.)

479 THE EFFECT OF THERMAL CYCLING ON THE SWELLING OF URANIUM. Ryukiti R. Hasiguti and Naohio Igata (Tokyo Univ.). p.527-31 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

Swelling of U under irradiation is accelerated by thermal cycling. A possible mechanism for this swelling that makes use of accelerated diffusion of fission gas atoms along dislocation pipes is discussed. (A.G.W.)

480 ON A THEORY OF SWELLING IN POROUS MATERIALS. V. M. Agranovich and E. Ya. Mikhlin (Nuclear Energy Inst., Academy of Sciences, Moscow). p.532-38 of "Properties of Reactor Materials and the Effects of Radiation Damage." London, Butterworths, 1962.

A theoretical description of the kinetics of swelling is presented. It was assumed that the fissioning material under discussion had an initial porous structure and the for-

mation of new pores at a later stage was neglected. In materials which are free from pores initially, the model will be applicable to the kinetics of swelling in the later stages when a sufficient number of pores have been formed. (A.G.W.)

481 URANIUM AND GRAPHITE. PROCEEDINGS OF A SYMPOSIUM HELD IN LONDON ON 20 AND 21 MARCH, 1962. MONOGRAPH NO. 27. London, Institute of Metals, 1962. 101p. $7.00.

Thirteen papers are included which chiefly treat the structure, mechanical properties, and radiation effects of uranium and graphite. One paper deals with oxidation of uranium in CO and CO_2. Separate abstracts were prepared for eleven of the papers; the remaining two papers have been previously abstracted in NSA. (D.L.C.)

482 GRAIN SIZE AND PREFERRED ORIENTATION OF URANIUM. B. R. Butcher (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.1-7 of "Uranium and Graphite." London, Institute of Metals, 1962.

Research into the physical metallurgy of uranium in relation to radiation effects is summarized, and preferred orientation and grain size are discussed. The problems involved in measurement are described, followed by details of experiments to ascertain the fundamental causes. Some practical aspects are also considered. (auth)

483 A RESISTOMETRIC STUDY OF THE BETA → ALPHA PHASE CHANGE IN A URANIUM—½% CHROMIUM ALLOY. P. H. Dixon and J. Burke (Univ. of Liverpool). p.9-16 of "Uranium and Graphite." London, Institute of Metals, 1962.

The $\beta \rightarrow \alpha$ transformation in a uranium–½ at.% chromium alloy at sub-critical temperatures was studied by resistivity, metallographic, and microhardness techniques. It is concluded that the time-temperature-transformation diagram consists of three C-curves. The highest-temperature C-curve covers the range 650 to 530°C and is associated with diffusion-controlled transformation. The intermediate curve extends from 530 to 400°C, and it is tentatively suggested that in this range reaction involves simultaneous lattice shear and short-range diffusion. The low-temperature C-curve applies to transformation by a shear mode. (auth)

484 THE EVALUATION OF CREEP TESTS ON ALPHA-URANIUM UNDER ISOTHERMAL AND THERMAL-CYCLING CONDITIONS. L. R. T. Gardner and W. N. Miller (United Kingdom Atomic Energy Authority, Springfields Works, Preston, Lancs, Eng.). p.25-8 of "Uranium and Graphite." London, Institute of Metals, 1962.

The creep data obtained for uranium by the United Kingdom Atomic Energy Authority, the Consortia, and the Central Electricity Generating Board during the last 2 to 3 years are reviewed, and isothermal secondary creep rates $\dot{\epsilon}$ (hr^{-1}) are fitted to a law of the type: $\dot{\epsilon} = \sigma^n \exp(A + B/T)$, where σ is the applied stress ($lb/in.^2$) and T is the absolute temperature (°K). The best fit for the acceptable data is given by A = –0.824, B = –23,4000, and n = 2.61. The effect of continuous thermal cycling on the isothermal creep rate is evaluated, and a procedure is given which predicts numerically the creep behavior of a specimen undergoing continuous thermal cycles greater than a few degrees. (auth)

485 LOCALIZED OXIDATION OF URANIUM IN CARBON DIOXIDE AND CARBON MONOXIDE IN THE RANGE 200-500°C. P. C. S. Hayfield, R. L. Graham, and G. Ramshaw (Imperial Chemical Industries, Ltd., Birmingham, Eng.). p.29-40 of "Uranium and Graphite." London, Institute of Metals, 1962.

Uranium, when heated in carbon dioxide or carbon monoxide over the range 200 to 500°C, forms a generally protective uranium dioxide film. In carbon dioxide at 400°C, this film reaches 2500 to 3500 Å in thickness, whereas in carbon monoxide the value is nearer 1500 Å. The limiting thickness of these uniform films is largely independent of impurity content of the corroding gas over the narrow range of concentrations studied. However, in the presence of impure gases an additional, localized oxidation may occur, and this form of attack is shown to be markedly enhanced by increasing the water vapor and oxygen content. Indeed, unless stringent precautions are taken to reduce such impurities to a level below that obtainable commercially, most of the attack is accounted for by localized oxidation. Various grades of uranium were examined in this investigation, including a sample containing 2000 ppm of impurities (referred to as Grade A). The corrosion rate of this grade of uranium exposed at 400°C to flowing carbon dioxide is reduced from 0.049 to 0.015 mg/cm^2-hr by lowering the air content of the gas from 80 to 20 ppm and the water content from 50 to 1 ppm. Two hypotheses were advanced to account for the formation of localized oxidation sites which, in Grade A material, are principally associated with uranium monocarbide inclusions. The first is based upon the fact that some decomposition of the inclusion occurs in the presence of moisture. The second visualizes cracking of the oxide film at discontinuities associated with uranium/uranium monocarbide interfaces, and with consequent intensified local attack. (auth)

486 THE RELATIONSHIP BETWEEN IRRADIATION GROWTH IN MONO- AND POLYCRYSTALLINE ALPHA-URANIUM. S. N. Buckley (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.41-4 of "Uranium and Graphite." London, Institute of Metals, 1962.

A study is made of two of the basic problems pertinent to the radiation distortion of metallic uranium fuel elements: how do grains of differing orientation grow anisotropically and yet remain coherent, and is the net growth rate influenced by intergranular stresses? Growth rates of monocrystals are found to be unaffected by external restraint up to 2000 $g\text{-}mm^{-2}$. Since higher stresses produce plastic deformation, it is concluded that the latter is the mechanism of differential strain accommodation in polycrystals. Periods of completely restrained growth elongation effect an appreciable reduction in the subsequent (i.e., stress-free) growth rate. The change is shown to be due to (130) twinning which rotates {010} and {100} crystal directions respectively away from and towards the axis of restraint. Net growth rates of polycrystals are found to increase with the degree of alignment of (010) plane poles. With weak texture the relationship is linear, but between 55 and 75% alignment the growth rate G rises sharply from ~300 to 900, and thereafter the variation with texture is small. The behavior of polycrystals is explained in terms of a simple model based on intergranular forces. (auth)

487 THE STUDY OF IRRADIATION DAMAGE IN URANIUM BY ELECTRON MICROSCOPY. M. J. Makin (Atomic Energy Research Establishment, Harwell, Berks, Eng.), W. H. Chatwin, J. H. Evans, B. Hudson, and E. D. Hyam. p.45-51 of "Uranium and Graphite." London, Institute of Metals, 1962.

The bulk physical properties of α-uranium are quite severely affected by several different phenomena during neutron irradiation, and it has been shown that the scale of the damage responsible is such that in many cases it is observable only by electron microscopy. A fairly detailed account of the various electron-microscope techniques

used in the U.K.A.E.A. Laboratories and some of the more notable results obtained are given. The replication of polished and etched surfaces has been extensively used to study the distribution of fission gas bubbles in uranium irradiated under various conditions and has given much valuable information on the swelling problem. The replication of fractured surfaces has revealed the formation of grain-boundary cavitation during irradiations in which large temperature variations have occurred. Extraction replicas have been used to study the precipitates formed when iron and aluminium are added to uranium to control the grain size and which appear also to influence the distribution of gas bubbles. Recently the thin-film transmission technique has been successfully applied to uranium and has revealed the formation of dislocation loops on certain crystal planes during irradiation. The strains produced by these loops are believed to constitute the mechanism of the irradiation-growth phenomenon. (auth)

488 THE SWELLING OF ALPHA-URANIUM UNDER NEUTRON IRRADIATION TO 0.7% BURN-UP. R. G. Bellamy (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.53-8 of "Uranium and Graphite." London, Institute of Metals, 1962.

Unalloyed uranium, into which minor compositional and structural variations were purposely introduced was irradiated at 550 to 575°C to burn-ups of up to 0.7% of all atoms. The results indicate that vacuum-cast and heat-treated uranium with additions of iron and aluminium has a high resistance to swelling, which is not affected by ~65,000 thermal cycles of ±5 or ±15°C. A tentative hypothesis ascribing swelling-resistance to the iron and aluminium additions can be extended to explain earlier apparent inconsistencies in swelling behavior, the incidence of breakaway swelling, and differences in fission gas-bubble size distribution and post-irradiation swelling behavior between uranium specimens of British and American origin. (auth)

489 THE PORE PROPERTIES OF GRAPHITES FOR NUCLEAR REACTOR APPLICATION. N. Godwin (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.), J. Bromley, and T. R. Jenkins. p.59-65 of "Uranium and Graphite." London, Institute of Metals, 1962.

The process of manufacturing moderator graphite from a coke grist and pitch binder is outlined. Examination of its porous nature by the determination of real and apparent density, gas permeability, pore-size distribution, and surface area by means of fluid penetration, adsorption, and flow, is described. Under reactor conditions the problem of corrosion of moderator graphite by a gaseous coolant arises, and reduction of such attack by modifying the porosity, particularly by impregnation, is being investigated. The use of graphite as a canning material for reactors operating at high temperatures necessitates the reduction of permeability, and various means of achieving this, including the use of fine-grained graphites, impregnation treatments, and pyrolytic deposition, are considered. Attention is drawn to the necessity for observing the effect of modification of pore structure on other properties of importance. (auth)

490 CONTROL OF ANISOTROPY IN THE MANUFACTURE OF GRAPHITE. D. G. Harris, A. B. Miller, and R. L. Craik (C. A. Parsons and Co., Ltd., Newcastle upon Tyne, Eng.). p.67-74 of "Uranium and Graphite." London, Institute of Metals, 1962.

Experimental extrusions of artificial graphites from nuclear-grade petroleum coke and pitch materials showed that the anisotropy of physical properties is governed by the initial particle shape of the crushed petroleum coke. Preferred orientation is developed during extrusion by the alignment of asymmetrically shaped particles in which a marked basal plane orientation effect is present. The degree and type of preferred orientation depend upon the proportions of these particles and the mode of fabrication adopted; it can be effectively reduced by pretreatment of the crushed coke by processes that eliminate particle-shape irregularity. Graphitizing above 1500°C does not alter the texture present, but causes growth of an "embryo" crystallite structure present in the original coke. Crystallite growth has an apparently linear relationship with temperature, irrespective of crystallographic direction. X-ray texture and thermal-expansion measurements, when expressed as ratios parallel and perpendicular to the direction of extrusion, show close agreement irrespective of the size-grading and source of the petroleum coke. Specific-resistance data show less obvious correlation with x-ray texture, suggesting that intercrystalline boundary conditions may be of more significance than the texture itself when undertaking theoretical predictions of resistivity from single-crystal data. (auth)

491 DIMENSIONAL EFFECTS IN GRAPHITE ON IRRADIATION. J. H. W. Simmons and W. N. Reynolds (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.75-80 of "Uranium and Graphite." London, Institute of Metals, 1962.

Measurements of the effect of irradiation at 150 to 650°C on the dimensions and on the thermal expansion of graphite are reported. In analyzing the results, it is necessary to distinguish between the physical expansion of a graphite crystal and the corresponding expansion of the crystal lattice as determined by x-ray diffraction methods. The expansion of the crystals was deduced from measurements on polycrystalline material using a theory that relates the growth and thermal expansion of the polycrystalline material to the growth and thermal expansion of the crystals. It is then found that under some irradiation conditions the crystal expansion in the c-direction is greater than the corresponding change in crystal-lattice spacing. This behavior is consistent with observations of defects in irradiated graphite in the electron microscope. The use of true crystal expansions in place of the expansions of the lattice spacing explains some hitherto puzzling features of the dimensional changes in graphite. (auth)

492 LATTICE DEFECTS IN GRAPHITE AND THEIR INFLUENCE ON PHYSICAL PROPERTIES. G. K. Williamson (Central Electricity Generating Board, Nuclear Labs., Berkeley, Gloucester, Eng.). p.87-93 of "Uranium and Graphite." London, Institute of Metals, 1962.

Electron-microscope observations of dislocations in graphite are described. The total absence of work-hardening or dislocation locking within the individual crystals arises because all dislocations have a common slip plane that contains all the Burgers vectors. The dislocation density in the crystallites in reactor graphite is ~10^{13} dislocations/cm^2, so that they should deform readily even under small loads. Deformation will be restricted, since the dislocations pile up at the grain boundaries. These elementary views correctly predict the stress/strain behavior of polycrystalline graphite. The behavior of vacancies in graphite was also studied in the electron microscope. There is no climb mechanism whereby vacancies can contribute to the distortion of the crystallites, except by normal Herring-Nabarro creep or by releasing the dislocations held up at grain boundaries. "Pseudo-creep" observed in thermal-cycling experiments can be shown to be a consequence of the stresses generated

by the anisotropic crystallite expansion. The origin of irradiation creep is still obscure. The effect of irradiation on the mechanical properties is to increase the frictional stresses required to move a dislocation. This has the effect of making the apparent elastic modulus increase, since the large compliance produced by dislocation movement is suppressed. (auth)

Corrosion

493 (BMI-X-10003) DEVELOPMENT OF NIOBIUM-BASE ALLOYS FOR USE IN A NUCLEAR SUPERHEATER. Quarterly Progress Report, April–June 1962. John A. DeMastry and Arthur A. Bauer (Battelle Memorial Inst., Columbus, Ohio). July 1, 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 7p. (EURAEC-425)

Research on Nb-base alloys for cladding and/or structural materials for use in steam at 1000 to 1300°F is reported. Corrosion data for test alloys after 2.7, 14, 21, 28, 42, and 56 days reveal that Zr additions are detrimental to corrosion resistance. Overall results obtained in corrosion tests to date indicate that Ti is the most effective alloying addition for improved corrosion resistance. Data obtained in tests of various binary compositions of Nb-Ti in 1000°F steam are tabulated. Ti-V alloys are being prepared for corrosion testing. (J.R.D.)

494 (EURAEC-376) MICROGRAVIMETRIC INVESTIGATION INTO THE MECHANISM OF CORROSION OF REACTOR MATERIALS IN THE PRESENCE OF NUCLEAR RADIATION. Quarterly Report No. 2, April 1 to June 30, 1962. (Battelle Institut e. V., Frankfurt am Main). Work Performed under United States–Euratom Joint Research and Development Program. Contract 071-62-12-RDD. 20p.

The individual components of the apparatus to be used for the corrosion studies were constructed and assembled. The apparatus is being tested for punctional reliability. The available small adsorption apparatus was used for corrosion experiments on technical-grade iron in the absence of radiation. These studies are to facilitate the programming of the individual experiments to be carried out with the large apparatus just completed. The corrosion tests in the absence of radiation are being carried out before delivery of the radiation source. (auth)

495 (HW-73511) HIGH TEMPERATURE OXIDATION OF ZIRCONIUM AND ZIRCALOY-2 IN OXYGEN AND WATER VAPOR. R. W. Westerman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 1962. Contract AT(45-1)-1350. 44p.

The high-temperature oxidation kinetics of zirconium and Zircaloy-2 in atmospheres of oxygen and water vapor were determined under conditions which would allow valid comparisons between materials and between environments. Oxygen was found to be a more potent oxidant than water vapor at the same pressure. The pre-transition oxidation kinetics of Zircaloy-2 were comparable with those of pure zirconium, both following a cubic rate law. The pre-transition oxidation kinetics of Zircaloy-2 were sensitive to water vapor pressure in the range of 5 to 25 mm, but were not sensitive to oxygen pressure. The post-transition oxidation kinetics of Zircaloy-2 were dependent on the pressure of either gas, indicating a gaseous diffusion rate control. Zirconium exhibited no transition in rate from the cubic over the duration of the exposure. It is shown that the rate-controlling mechanism which results in the cubic rate law is not directly dependent on the total thickness of the oxide layer. Activation energies for the cubic rate law, rate-controlling mechansim lie in the range 50 to 63 kcal/mol, indicating that similar mechanisms are operative, regardless of material or atmosphere. (auth)

496 (KAPL-2000-19) REACTOR TECHNOLOGY REPORT NO. 22—CHEMISTRY. (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 1962. Contract W-31-109-eng-52. 107p.

Five sections are included for which separate abstracts were prepared. (J.R.D.)

497 (KAPL-2000-19(p.I.1-I.28)) ANALYTICAL CHEMISTRY. D. A. Del Grosso, J. R. Ciaranello, et al. (Knolls Atomic Power Lab., Schenectady, N. Y.).

Methods development for emission of spectrochemical determination of rare earths in stainless steel are described. It is noted that slightly high recoveries were the rule for this procedure. Other work was devoted to the determination of metallic traces in solutions by x-ray fluorescence analysis, and determination of O_2 in Zircaloy by fast neutron activation. Development of density-measuring equipment for use with objects several feet long and weighing up to 3 kg is reported. The equipment is capable of evaluating a metallic sample of density to about 6 to 5 significant figures. (J.R.D.)

498 (KAPL-2000-19(p.II.1-II.13)) CORROSION CHEMISTRY. C. F. Cheng, C. L. Crenshaw, et al. (Knolls Atomic Power Lab., Schenectady, N. Y.).

Activities in test programs concerning corrosion of Inconel in lithiated water are reported. Inconel test coupons were exposed to dilute aqueous LiOH at 550°C at flow velocities of 15 and 30 ft/sec. The solution also contained 20 cc H_2/kg of water. Results of these tests are summarized in sections on general corrosion, stress corrosion, and crevice and galvanic corrosion. (J.R.D.)

499 (KAPL-2000-19(p.III.1-III.9)) ZIRCALOY AND ZIRCONIUM CORROSION. A. M. Andrako, A. E. Bibb, et al. (Knolls Atomic Power Lab., Schenectady, N. Y.).

Studies concerning the corrosion behavior of Zr single crystals in 680°F deoxygenated, deionized water are described. The studies are being conducted in autoclaves under static conditions to obtain data on aqueous corrosion of Zr and to determine the crystallographic orientation of Zr that is most corrosion resistant. Data obtained in these studies are tabulated and discussed. In other work, corrosion investigations were conducted on Inconel–Zircaloy-2 and Type 304 stainless steel–Zircaloy-2 eutectic bonds in ammoniated water at 600°F. Exposures of 1000 hr resulted in cracking through-out the width of the bonds. Data from corrosion tests of Zircaloy-2 in 14.5 M NH_4OH solutions at 680°F are included along with data on steam corrosion of Hf-Zircaloy bonds at 750°F. (J.R.D.)

500 (KAPL-2000-19(P.IV.1-IV.11)) OTHER MATERIALS. A. M. Andrako, B. E. Dearing, et al. (Knolls Atomic Power Lab., Schenectady, N. Y.).

Tests are described which were conducted to explore the deleterious effects of H_2 levels on the corrosion resistance of Hf to high-temperature water. Corrosion specimens of Hf were prepared which contained from 0 to 700 ppm H_2. These coupons were exposed to 680°F deoxygenated deionized water or to 750°F steam. Test data from these investigations are tabulated. In other work, high Ni alloys and weld overlays containing 46 to 76% Ni, 7 to 24% Cr, and 0.1 to 16% Mo in Fe were investigated for chloride stress corrosion and cracking. Tests were carried out in aerated boiler water (500 ppm chloride) at 500°F and in

sea water (18,600 ppm chloride) at 550°F. Test results are tabulated. Results of corrosion tests involving Cu, Ni-plated Cu, and Inconel-clad Cu in 600°F static water are also included. (J.R.D.)

501 (KAPL-2000-19(p.V.1-V.31)) PHYSICAL AND PROCESS CHEMISTRY. M. S. Bushey, M. E. Jones, et al. (Knolls Atomic Power Lab., Schenectady, N. Y.).

The structural materials commonly used in high-temperature water systems are being studied to determine the behavior of constituent elements in corrosion and release processes. Data are presented in graphic form concerning the theoretical behavior of Fe–water systems, Ni–water systems, and Cr–water systems at 25°C. In other work, tests to determine whether or not ammonia accumulates in void spaces of high-temperature ammoniated water systems are reported. Research devoted to corrosion of Zircaloy is reported in which special attention is given to composition and behavior of the black surface oxide formed on this alloy. Investigation of fluoride corrosion of Zircaloy is also reported along with data on physical characteristics of coolant crud samples. (J.R.D.)

502 (EURAEC-293) CORROSION OF NUCLEAR MATERIALS. Special Report No. 3, March 1960 through December 1961. (Brussels. Centre Belge d'Etude de la Corrosion). Apr. 18, 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract 006-60-3RDB. 88p. A translation.

An electrochemical investigation of the circumstances accompanying local corrosion and the conditions of non-corrosion of types 304, 316, and 410 stainless steel in the presence of 0.10 M sodium bicarbonate containing various amounts of sodium chloride at 20°C was conducted. The influence of surface conditions and thermal treatments is described. On the basis of break-through potential and protection potential, criteria were deduced which made it possible to predetermine the circumstances under which oxidizing or reducing action causes local corrosion or protects the steels from corrosion. The validity of the predeterminations was checked by corrosimetric and corrosiscopic tests on the influence of oxidizing substances (hypochlorite, permanganate, hydrogen peroxide, and oxygen) and the influence of anodic and cathodic polarization had on the behavior of the stainless steels in chlorinated bicarbonate solutions. Results are presented in tabular and graphical form. (auth)

503 BERYLLIUM CORROSION. John R. Steele (Beryllium Corp., Reading, Penna.). Mater. Protect., 1: No. 7, 59-62(July 1962).

The corrosion resistance of Be is influenced by impurities in the metal. Impurities that could be derived from the manufacturing process of extracting Be from ore are shown to lower corrosion resistance as measured by humidity tests. Variations in machined surface finishes, chemistry, and the manufactured forms of the product were examined under cyclic humidity conditions. Vacuum deposits of Ag, Ni, Zr, SiO, Al, and Ti over Be were examined under similar conditions of humidity as well as for atmospheric corrosion at 1600°F. Electroplating techniques and compatibility of Be in organic cleaning solvents are discussed. Techniques of handling Be are discussed briefly. (auth)

504 ZIRCONIUM-2.5 WT. % NIOBIUM ALLOYS FOR WATER-COOLED POWER REACTORS. W. R. Thomas (Atomic Energy of Canada Ltd., Chalk River, Ont.). Preprint. [Ottawa], Canadian Nuclear Association, 1962. 14p.

Results of a program to determine the suitability of a Zr-2.5% Nb alloy for use in water-cooled power reactors are presented. Data are included on the following: corrosion in water, steam, air, and CO_2; tensile and impact properties before and after irradiation; creep; fabrication and heat treatment. It is concluded that the alloy will be an advantageous replacement for Zircaloy-2 in water-cooled power reactors. Corrosion rates are acceptable, and the higher strength of the alloy will permit a decrease of parasitic material in the reactor core and better neutron economy. (A.G.W.)

Fabrication

505 (AD-272693) HIGH ENERGY RATE METAL WORKING BIBLIOGRAPHY. Final Report, July 1, 1960–January 1, 1962. (North American Aviation, Inc., Columbus, Ohio). Jan. 1962. 219p. (NA62H-46)

A bibliography is presented on high-energy-rate metal working. Abstracts are included. About 450 references are listed. (J.R.D.)

506 (AD-273120) ROLLING IMPROVED BERYLLIUM SHEET. Technical Report 239-234. Quarterly Report No. 2, October 5, 1961 to January 4, 1962. E. M. Grala, R. G. O'Rourke, G. L. Marsh, and L. S. Busch (Brush Beryllium Co., Cleveland). Contract AF33(600)-43037. 30p.

The effect of rolling temperatures on the tensile properties of Be sheet was determined. Flatness and tensile data on finishing operations are presented. Biaxial ductility of annealed sheet is reported. (auth)

507 (ASD-TR-7-785(VII)) MOLYBDENUM ALLOY EXTRUSION DEVELOPMENT PROGRAM. Seventh Interim Technical Engineering and Phase III Report, June 1, 1962 to September 1, 1962. (Allegheny Ludlum Steel Corp. Research Center, Brackenridge, Penna.). Sept. 1962. Contract AF33(600)-40861. 60p.

Full length "T" shape extrusions of TZM were made within target requirements from 3200 to 3400°F billet heating temperature with a reduction ratio of about 19:1. High liner pressure in excess of 200 ksi was required to accomplish these extrusions. Surface quality was better than 150 RMS on full length extrusions. Few areas of glass or die coating rubin appeared but could be removed by light conditioning. By careful application of the die coating, followed by grinding and polishing the coated surface to a finish of 100 RMS or better, striations were almost completely eliminated. Good die performance resulting in less than 0.010 inch run-out on full length extrusions was achieved with zirconia coated dies. (auth)

508 (BMI-1597) GAS-PRESSURE BONDING OF STAINLESS STEEL-CLAD UO_2 FLAT-PLATE ELEMENTS. Stan J. Paprocki, Stanley W. Porembka, Edwin S. Hodge, and Charles B. Boyer (Battelle Memorial Inst., Columbus, Ohio). Oct. 5, 1962. Contract W-7405-eng-92. 26p.

The effects of process variables in the gas-pressure bonding of stainless steel-clad flat-plate fuel elements containing rolled and sintered UO_2 cores 3 in. long were investigated. Selection of a suitable type of stainless alloy for this cladding application was also of interest in the study. A bonding cycle in which the element was brought to 2100°F at 300 to 500 psi and then subjected to the full bonding pressure of 10,000 psi at temperature for 2 hr gave best results. Type 347 stainless steel, from the standpoint of bonding behavior, absence of excessive grain coarsening, and avoidance of carbide precipitation, appeared acceptable for this application, but further study would be

necessary before an optimum cladding alloy could be recommended. (auth)

509 (CW-R&DL-29) WELDING OF ZIRCONIUM–2.5 w/o NIOBIUM AND ZIRCONIUM–3.0 w/o ALUMINUM–0.5 w/o MOLYBDENUM ALLOYS. M. J. Lavigne (Canadian Westinghouse Co., Ltd., Atomic Energy Div., Hamilton, Ont.). June 29, 1962. 55p. (AECL-1610).

The high-strength Zr alloys Zr–2.5 wt % Nb and Zr–3.0 wt % Al–0.5 wt % Mo were welded under various atmospheres, and the welds were evaluated by nondestructive testing, chemical analysis, metallographic examination, and tensile testing at room temperature and 315°C. The Zr–Nb welds were also evaluated by corrosion testing in 360°C water after various heat treatments and surface treatments before and after welding. In addition, the welding of Zr–2.5 Nb to Zircaloy-2 was investigated. The alloys are readily weldable by the inert W-arc welding process and although the weld-shielding atmosphere has no apparent effect on the mechanical properties of the welds, the corrosion resistance of the Zr–Nb alloy is affected. The best corrosion resistance is obtained with the highest purity, gas-shielding conditions. Vapor blasting and pickling after welding resulted in some improvement in corrosion resistance of welds made under the various atmospheres. Heat treating after welding followed by vapor blasting and pickling improves the corrosion resistance of the Zr–Nb alloys. The corrosion resistance of the heat-affected zone is impaired in the Zr–Nb material, whether welded, as-received, or heat-treated. A complete solution and aging treatment would probably be required to restore the corrosion resistance. Welding in a pre-evacuated box (0.01 μ), back-filled with purified Ar, is considered to be more suitable for the welding of thick sections or complicated shapes of Zr–Nb and Zr–Al–Mo alloys. (auth)

510 (CWAED-54) DEVELOPMENT OF A TUBE-TO-TUBE SHEET JOINT FOR DOUGLAS POINT REACTOR CALANDRIA. R. Westwood and D. L. Paterson (Canadian Westinghouse Co., Ltd. Atomic Energy Div., Hamilton, Ont.). May 31, 1962. 61p. (AECL-1611)

A summary of results of tests conducted on various unsuccessful rolled joint concepts investigated in the Douglas Point calandria development program is presented. Details are also given concerning development of the landed sleeve sandwich joint which was adapted for this calandria. (J.R.D.)

511 (DMIC-174) ELECTRON-BEAM PROCESSES. H. W. Mishler and R. E. Monroe (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Sept. 15, 1962. Contract AF18(600)-1375. 54p.

The operation of the electron-beam process for welding, melting, and machining is described. The different classes of equipment for each of the three processes are discussed, and commercially available equipment, both domestic and foreign, is described and illustrated. (auth)

512 (DMIC-Memo-158) SUMMARY OF THE SECOND AND THIRD TECHNICAL BRIEFINGS ON REFRACTORY METAL ALLOY STRUCTURAL FASTENERS. W. S. Hyler and R. M. Evans (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Oct. 8, 1962. 24p.

Activities in a program to develop manufacturing techniques for production of refractory metal fasteners and to obtain data on design of fasteners already being produced are reported. Activities primarily emphasized during the period are concerned with design of the thread on bolts and nuts. (J.R.D.)

513 (HW-64684) URANIUM DIOXIDE FABRICATION. D. W. Brite and R. J. Anicetti (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 5, 1960. Contract AT(45-1)-1350. 117p.

The techniques developed for fabricating UO_2 fuel element cores and swageable powders at HAPO are described. A simplified flow chart of some of the processes is presented. Types of fuel cores fabricated since the program began in 1956 are indicated. The experiences and observations are related both in fabricating the uranium dioxide fuel element cores for the variety of test element studied in connection with the Plutonium Recycle Program and in fabricating the dense granular uranium dioxide used for the PRTR fuel loading of swaged 19-rod cluster fuel elements. Types of UO_2 powders encountered and methods of characterizing, activating, and preparing them for forming operations are detailed. Cold pressing, isostatic pressing, extrusion, and high energy impact forming processes are described, as are sintering, machining, and crushing operations. (auth)

514 (NAA-SR-7138) MULTICYCLE REPROCESSING AND REFABRICATION EXPERIMENTS ON SIMULATED UO_2-FISSIA PELLETS. S. Strausberg (Atomics International. Div. of North American Aviation Inc., Canoga Park, Calif.). Aug. 30, 1962. Contract AT(11-1)-Gen-8. 51p.

Experiments were carried out with unirradiated materials, simulating the recycle of UO_2 fuel through a reactor to a total burnup of approximately 100,000 Mwd/MTU. For each cycle, refractory fuel shapes were pulverized by gaseous oxidation-reduction treatments, and then refabricated by conventional cold-pressing and sintering techniques. The results indicated that accumulated fission products (added to UO_2 powders in the form of stable isotopes, in amounts equivalent to 2 at. % burnup per cycle) will not impair the reprocessing or refabrication of refractory UO_2 fuels. To the contrary, it appeared that powders simulating high burnup may sinter to a greater extent than pure UO_2 powders. A rapid method was developed for the analysis of simulated fission products present in small quantities in urania powders. The results, obtained by x-ray spectrographic techniques, indicated that Cs was the only component removed during reprocessing or fabrication; the remaining constituents (Sr, Y, Zr, Nb, Mo, Ru, Ba, La, and the rare earths) were still detected in their originally added amounts. (auth)

515 (NLCO-857) THREE-ROLL ROTARY-PIERCING OPERATION FOR THE FABRICATION OF URANIUM TUBES. H. Davis and J. F. Schiltz (National Lead Co. of Ohio, Cincinnati). Oct. 5, 1962. Contract AT(30-1)-1156. 34p.

Two tests were performed to evaluate the feasibility of rotary-piercing reactor-grade uranium in the high alpha temperature range. Rotary piercing is one process under consideration in an alternate route being developed for the production of uranium fuel cores. The tests were performed in three-roll Witter mills designed for use with steel. While the tests were only partially successful, sufficient data were obtained to establish limits for preheat temperatures, deformation rates, and roll pass designs for use in future rotary-piercing tests. Technical problems requiring further study are discussed. (auth)

516 (NMI-4313(Pt.I)) FABRICATION AND PROPERTIES OF EXTRUDED URANIUM TUBES. J. L. Klein, J. M. Fitzpatrick, R. N. Randall, P. Loewenstein, H. J. Cleary, R. B. Russell, and J. Wong (Nuclear Metals, Inc.,

Concord, Mass.). Sept. 30, 1959. Contract AT(30-1)-1565. 142p.

Extrusion methods for producing large diameter bare uranium tubes are described and discussed. The tubes have a wall thickness of ¼-in. and diameters ranging from 2 to 3 inches. Relatively close dimensional tolerances (±10 mils on OD and ID and ±15 mils on wall thickness) were required. Results show that extrusion in the high alpha temperature range (1100 to 1200°F) gives satisfactory results, but extrusion in the gamma range gives poor dimensional tolerances. Suitable methods for preworking of cast uranium for grain refinement include alpha working by hammer forging, press forging, and pre-extrusion, or a heat treatment consisting of a triple beta quench. To prevent the uranium from oxidation during heating for extrusion and to separate it from the extrusion tools it is necessary to coat the uranium with copper. Thickness measurements are discussed in detail along with gage designs. (auth)

517 (NOTS-TP-2616) AN INVESTIGATION OF THE FEASIBILITY OF FORMING ALLOY COATINGS WITH A PLASMA JET. G. A. Hayes and U. L. Johns (Naval Ordnance Test Station, Inyokern (China Lake), Calif.). Feb. 2, 1961. 38p. (NAVWEPS-REPORT-7617)

Effort was directed toward forming alloy coatings by spraying mixtures of metal powders with a plasma jet. Various process variables were controlled to determine the optimum plasma spraying conditions. X-ray diffraction techniques, metallographic examination, chemical analysis, and density and microhardness measurements were used to evaluate each coating. Alloy coatings of Mo–Fe and Ti–Ni were successfully formed. (auth)

518 (NP-12152) ROLLING IMPROVED BERYLLIUM SHEET. PHASE II–REPORT, ISOTROPIC DUCTILITY. Technical Report 279-234, March 26, 1962 to May 25, 1962. E. M. Grala, R. G. O'Rourke, H. F. Larson, and J. N. Hurd (Brush Beryllium Co., Cleveland). Aug. 1962. Contract AF33(600)-43037. 41p.

The effect of heat treating at 1750, 1920, and 2020°F for intervals of 6, 60, and 600 min, on the tensile properties and third dimension plastic strain of cross-rolled Be sheet was investigated. Differences in the effects of the heat treatments were shown to be statistically significant with characteristic patterns appearing for the various properties. The average effect of these treatments was to reduce the ultimate strength from 78,400 to 58,400 psi, the yield strength from 60,700 to 32,700 psi and the elongation from 15.5 to 8.1%. The response of the third dimension plastic strain to these same treatments was to increase the average value from 0.58 to 0.77%. (auth)

519 (WAL-TR-642.4/1) CAUSES OF MICRO-FLAWS IN HIGH-STRENGTH WELD METALS, THEIR EFFECTS, AND METHODS OF ELIMINATING THEM. Final Report. M. D. Randall, R. E. Monroe, and P. J. Rieppel (Battelle Memorial Inst., Columbus, Ohio). July 31, 1961. Contract DA-33-019-ORD-3402. 55p.

Research was conducted to study the causes of micro-defects in high-strength steel welds, determine the effects of such microdefects on weldment performance, and determine methods for eliminating such defects. Welds were deposited in air-melted and vacuum-melted 300M steel by the inert-gas-shielded, W-arc and electron-beam welding processes. Tension, bend, and impact tests were made of these weldments and base plate. Metallographic examination and supplementary studies were made. It was determined that micro-defects can cause low-load failure. These defects occur at temperatures near the alloy solidus temperature and are chemistry controlled. Microsegregation of S, P, and Si occurs in these welds, and Si lowers elevated-temperature ductility and promotes hot cracking. Grain-boundary liquation of heat-affected zones occurs. (auth)

520 (EURAEC-351) APPLICATION OF THE ELECTRO-SLAG PROCESS TO THE WELDING OF THICK STEEL COMPONENTS UNDER WORKSHOP AND ON-SITE CONDITIONS. Quarterly Report No. 1, January 1–March 31, 1962. (Chantiers de l'Atlantique Penhoet-Loire, Paris). Work Performed Under United States–Euratom Joint Research and Development Program. 10p. A translation.

Visual inspection, dimensional inspection and ultrasonic testing were carried out on two Mn–Mo sheets. The surface condition after descaling was satisfactory for sheets of the thickness considered. With reference to the nominal thickness, the dimensions noted showed maximum variations of 2%. The ultrasonic check detected spot defects located at mid-thickness and of light character only. (M.C.G.)

521 (EURAEC-369) FABRICATION OF UO_2 AND UO_2BeO MIXED PELLETS. Final Report, December 15, 1960–April 30, 1962. (Battelle Institut e.V., Frankfurt am Main). June 28, 1962. Work Performed Under United States–Euratom Joint Research and Development Program. Contract 015-60-9RDA. 21p. A Translation.

Research work devoted to fabrication of UO_2 and BeO-UO_2 sintered particle systems is described. Properties of these fabrications such as thermal expansion up to 1100°C and thermal conductivity at 800 to 1100°C were also investigated. Results show that thermal conductivity increases with increase in the BeO content. A functional dependence of thermal expansion on BeO content was not established. (J.R.D.)

522 MANUFACTURE AND CONTROL OF STAINLESS STEEL TUBES FOR D_2O–H_2O HEAT EXCHANGER. B. Loefblad (Stahlwerke Sandvik AG, Sandviken, Sweden). Kerntechnik, 4: 334-8(Aug. 1962). (In German)

The fabrication and inspection of 30,000 m of stainless heat exchanger tubing is described. The tubes are used in two main heat exchangers in the first Swedish power and heat producing nuclear reactor. This reactor Agesta (R 3/Adam), is now being built south of Stockholm and has a maximum output of 65 Mw. The fuel is UO_2 canned in Zircaloy. Heavy water is used for cooling and moderating the reactor. The primary medium in the heat exchanger is thus heavy water, which circulates inside the tubes with high speed. The reasons for the choice of austenitic stainless steel with extra low carbon content are presented. Very high demands on the analysis of the material, manufacturing methods, and inspection methods are stipulated. During the melting of the steel a radioactive isotope was added to the charge in order to completely insure against the risk of mixing the material during later stages of production. The final inspection of the tubes is extensive. Among other tests every tube is examined with eddy-current and ultrasound. Due to freedom from nonmetallic inclusions in the steel and because of the uniform analysis of the steel and accurate control during the different manufacturing stages it has been possible to fulfill the high requirements on surface finish and freedom from defects in the finished tubes. (auth)

523 MANUFACTURING THE KAHL PRESSURE VESSEL. H. Droscha. Kerntechnik, 4: 339-40(Aug. 1962). (In German)

Experiences gained in meeting special metallurgical and

technical requirements in connection with construction of pressure vessel for Kahl reactor were utilized partly in manufacturing the pressure vessel for Dragon reactor. The features are discussed: cobalt content of basic raw material kept to a minimum; type of platings and methods of application; special features of welding processes, grinding and polishing, and of sealing between cylindrical part and semispherical cupola. (auth)

524 IMPROVEMENTS IN WELDING. (to Babcock and Wilcox, Ltd.). British Patent 906,576. Sept. 26, 1962.

A process for welding low-alloy-content steels is given which is particularly useful for welding thick workpieces on site, such as in the construction of large reactor containment vessels. The process comprises preheating the weld members to a first temperature (200 to 250°C), depositing at least one layer of weld metal on each weld face, cooling the members and layers at a rate to avoid forming an undesirably hard structure, bringing the members together for welding, heating the layers of the weld metal to a second temperature (100 to 125°C), and uniting the members by depositing more weld metal between the layers. The weld metal has a low C content relative to that of the members, substantially the same mechanical properties, and a smaller tendency to harden on cooling. (D.L.C.)

Properties and Structure

525 (AFCRL-922) MAGNETIC PROPERTIES OF SPINS IN SOLIDS AT LOW CONCENTRATIONS. Scientific Report No. 2. J. Kaplan (Brandeis Univ., Waltham, Mass.). Dec. 1, 1961. Contract AF 19(604)-4107. 43p. (AD-271658)

A number of the properties of spins situated at lattice sites whose concentration relative to the total number of lattice sites is low are considered. The assumption of low concentration allows an expansion of the different spin properties in terms of concentration, a series which is generally convergent at low concentrations. There may be an interaction between spin sites (through lattice strain or coulomb interaction) which will alter the random distribution. A suitable adjustment can be made for this possibility. The spins are of one type and the site interaction is defined by a suitable spin Hamiltonian. The interaction between spins is dipolar, exchange etc. It is also assumed the spins interact with the lattice by suitably defined spin lattice interactions. If each local spin has several energy levels, transitions between each level may be associated with a separate spin lattice relaxation time. The spins may be electronic or nuclear; nuclear spins have the simplicity of being almost certainly randomly situated if they differ by only being an isotope of the background type. (auth)

526 (ARF-2230-12) DELAYED FAILURE HYDROGEN EMBRITTLEMENT OF ZIRCONIUM. Summary Report, September 15, 1961 to September 14, 1962. D. Weinstein and F. C. Holtz (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Oct. 10, 1962. Contract AT(11-1)-578. 58p.

The extent to which zirconium and zirconium alloys exhibit delayed failure (static fatigue) as caused by a combination of absorbed hydrogen and applied stress was investigated. Susceptibility to time-dependent fracture was evaluated for unalloyed zirconium and Zircaloy-2 with 200 and 500 ppm hydrogen as well as for an experimental Zr–Al–Sn–Mo alloy and the Canadian Zr–2.5Nb cladding material. For unalloyed zirconium and Zircaloy-2 containing up to 500 ppm hydrogen, no room-temperature, time-dependent fracture occurred which could be definitely attributed to the delayed failure phenomenon; an increased grain size, 20% cold deformation by rolling, or corrosion in 750°F steam did not significantly affect this behavior. The curve of applied stress versus time to failure at room temperature for the high-strength Zr–Al–Sn–Mo alloy containing 500 ppm hydrogen established a strong susceptibility to delayed failure due to hydrogen absorption; studies on vacuum-annealed material showed no failures. Further, reduced temperatures indicated that the occurrence of static fatigue is temperature dependent. Data for heat-treated Zr 2.5Nb containing 500 ppm hydrogen indicated that this material is moderately sensitive to delayed failure at room temperature; higher hydrogen contents caused a greatly increased susceptibility to time-dependent fracture. (auth)

527 (ATL-A-131) INVESTIGATION OF THERMAL-STRESS-FATIGUE BEHAVIOR OF STAINLESS STEELS. Quarterly Technical Progress Report, April–June 1962. K. E. Horton (Advanced Technology Labs. Div. of American-Standard, Mountain View, Calif.). Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-250. 13p. (EURAEC-335)

Activities in a program to obtain data on thermal-stress-fatigue in various stainless steels under reactor conditions are reported. Information concerning procurement of equipment and materials is given along results of initial testing. A specimen of 304 stainless steel was strain-rate tested at 100 to 900°C. The averaged result of this test was 0.0005 in./in.-sec. Tensile testing of standard ASTM ½-in.-dia stainless steel rods is underway. Data obtained so far in the program are compared with that obtained earlier by other investigators. (J.R.D.)

528 (BM-RI-6079) TITANIUM–IRIDIUM PHASE DIAGRAM. J. G. Croeni, C. E. Armantrout, and H. Kato (Bureau of Mines. Albany Metallurgy Research Center, Ore.). Jan. 1962. Contract AT(11-1)-599. 18p.

The Ti–Ir alloy system was investigated for further use in reactor control rods. Results indicate that alloys containing 10 at.% Ir may exhibit useful properties. These alloys should exhibit high strength, elevated temperature stability, and improved corrosion resistance. Alloys containing 45 to 55 at.% Ir also appear promising because of their hardness, forgeability, high neutron cross section, high melting point, and oxidation resistance. Phase data are included for several compositions. (J.R.D.)

529 (BMI-X-10007) FISSION-PRODUCT RELEASE FROM FUEL-ELEMENT CLADDINGS. Quarterly Progress Report for April–June 1962. Arthur A. Bauer (Battelle Memorial Inst., Columbus, Ohio). July 1, 1962. Work performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 31p. (EURAEC-426)

A fourth out-of-pile Xe^{133} release experiment was performed using 2-mil iron–chromium foils impregnated with a fission-product concentration of 1.67×10^{13} fission recoils per cm^2. The data show that temperature and fission-product concentration affect the amount of Xe^{133} released in the initial burst. Two experiments were performed to determine the feasibility of using a static system for studying fission-gas release. In the solid-fission-product diffusion studies, results were obtained on the distribution of Ce^{141} in the first diffusion couple. In three in-pile experiments, measurable amounts of all fission gases and significant amounts of Xe^{133} and I^{133} were released at tempera-

tures approaching 1200°C from the surfaces of tubular specimens loaded with UO_2. As a result of the experiments it was concluded that irradiation to 1.67×10^{13} fission per cm^2 induces dislocations. Bubbles were formed when the irradiated specimen was subsequently annealed at 800°C and higher. The concentration of bubbles increased with increasing annealing temperature. It was found that etch pits can be produced by cathodic vacuum etching. (M.C.G.)

530 (DRI-2042) INTERMEDIATE-TEMPERATURE OXIDATION OF BERYLLIDES. Quarterly Progress Report, March 1 to June 1, 1962. Frank C. Perkins (Denver. Univ. Denver Research Inst.). June 1, 1962. Contract AT(11-1)-1092. 34p.

Activities in a program to investigate the oxidation kinetics and characteristics of $ZrBe_{13}$, Zr_2Be_{17}, $NbBe_{12}$, and Nb_2Be_{17} at 1200 to 1800°F are reported. Wet and dry air runs were conducted to obtain thermogravimetric data. Data from x-ray-diffraction experiments are also included. (J.R.D.)

531 (EURAEC-320) THE EFFECT OF RADIATION ON THE DUCTILE-BRITTLE TRANSITION ON PRESSURE VESSEL STEELS. Quarterly Report No. V, January 1–March 31, 1962. E. Anderson, W. Bollmann, D. King, M. Malone, and J. Spreadborough (Battelle Memorial Inst. International Div., Geneva). Work performed under United States–Euratom Joint Research and Development Program. Contract 041-60-12RDS. 128p.

Activities in a program to extend understanding of neutron-induced embrittlement of reactor pressure vessel steels are reported. The program includes a study of binary ferritic alloys and iron. The mechanical properties of ARMCO iron samples are discussed along with tensile test results. Other discussion is included on the phenomena associated with subsequent extension in materials after yield points, without appreciable increase in load (Lueders bands). (J.R.D.)

532 (GEMP-105) PROPERTIES OF BERYLLIUM INTERMETALLIC COMPOUNDS. E. A. Aitken and J. P. Smith (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). July 1961. Contract AT(40-1)-2847. 29p.

Properties of intermetallic compounds of beryllium (beryllides) were measured to 2750°F (1510°C). Most of the data show that several beryllides, in particular $ZrBe_{13}$ and $NbBe_{12}$, hold promise for use as structural, fuel-moderator matrix, or heat sink materials to at least 2500°F (1370°C). The results indicate that impurities in the fabricated bodies and atmospheric moisture are very critical in determining properties over the entire useful temperature range. (auth)

533 (MSAR-61-29) EFFECT OF 1200 F SODIUM ON AUSTENITIC AND FERRITIC STEELS, PART I. PHYSICAL PROPERTIES OF MATERIALS. PART II. THERMAL SHOCK. Progress Report No. 6, February 1961. (MSA Research Corp., Callery, Penna.). Mar. 10, 1961. Contract AT(11-1)-765. 18p.

Equipment and procedures are being developed to study the effects of sodium at 1200°F on Croloy and stainless steel. Creep, tensile, stress-to-rupture, and fatigue test programs are discussed. Thermal shock studies planned for dissimilar metal welds between ferritic steel and stainless steel are described. (M.C.G.)

534 (MSAR-62-23) EFFECT OF 1200 F SODIUM ON AUSTENITIC AND FERRITIC STEELS. PART I. PHYSICAL PROPERTIES OF MATERIALS. PART II. THERMAL SHOCK. Progress Report 18, February 1962. (MSA Research Corp., Callery, Penna.). Mar. 13, 1962. Contract AT(11-1)-765. 8p.

Activities in a program to determine the effects of Na at 1200°F on stainless steel, and Na at 1100°F on Cr-Mo steels are reported. Cr-Mo specimens were fatigue tested in air at 1100°F during the period. Data obtained in these tests are given along with other tensile and rupture tests on stainless steels and Cr-Mo steels in air and He at 1100 and 1200°F. (J.R.D.)

535 (NAA-SR-Memo-7354) INTERIM REPORT ON THE PHYSICAL AND MECHANICAL METALLURGY OF APM M-257. R. A. Harlow and R. D. Hahn (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 30, 1962. Contract [AT-11-1-GEN-8]. 35p.

The physical and mechanical metallurgy of APM M-257 and XAP-001 is reported. Tensile data for M-257 sheet, bar, and tubing were somewhat scattered at room temperature, and became more uniform at elevated temperatures. The strength values for all three forms were in fairly good agreement. The yield strengths of sheet material increased slightly with increasing strain rate. The tensile properties of M-257 sheet were not significantly affected by soaking treatments at 800 and 1000°F for periods up to 5000 hours. The tensile and creep properties of XAP-001 bar stock compared favorably with earlier data on M-257. Limited data indicated that M-257 is not notch sensitive. Burst tests performed on M-257 tubing showed that the ultimate hoop strengths were slightly lower than the ultimate tensile strengths. XAP-001 exhibits an improved microstructure compared to earlier M-257, although efforts for further improvement are recommended. (auth)

536 (NP-12128) METALLURGICAL EXAMINATION OF DILUTE URANIUM–MOLYBDENUM–IRON ALLOYS. C. Fizzotti (Italy. Comitato Nazionale per l'Energia Nucleare. Divisione Materiali, Rome). June 1962. 28p. (RT/MET(62)3)

Ternary alloys of uranium containing molybdenum and iron were investigated; addition of iron causes the formation of the compound U_6Fe and increases the molybdenum concentration in the remaining metallic matrix. The structures obtained in the ternary alloys by different thermal treatments are shown and compared to the corresponding binary alloys. (auth)

537 (TID-17006) TRANSFORMATION CHARACTERISTICS OF ZIRCONIUM–NIOBIUM ALLOYS. Interim Technical Report No. 2. D. J. Cometto and R. F. Hehemann (Case Inst. of Tech., Cleveland). July 31, 1959. Contract AT(11-1)-588. 42p.

The quenched structures of Zr–Nb alloys can be divided into three groups. Group I (0 to 6% niobium) are martensitic alpha. A coherent form of omega appears in the quenched structure of Group II (7 to 16% Nb) alloys while Group III (more than 17% Nb) alloys consist of retained beta plus small amounts of a tetragonal phase. The omega that forms on quenching of Group II alloys appears to be coherent with beta and supersaturated in Nb. Omega in aged alloys appears to be incoherent and to have a composition dictated by equilibrium considerations. That is, at constant temperature, the composition of aged omega appears to be independent of Nb content of the alloy. On low temperature aging, Group II alloy show a rapid increase (no induction period) in hardness and decrease in volume while an induction period precedes hardness and volume changes of Group III alloys. These apparently pronounced differences in behavior can be correlated in terms of the

loss of supersaturation and coherency of quenched omega in Group II alloys. The general characteristics of the omega transformation were analyzed in terms of qualitative free energy curves for the Zr–Nb system. This analy sis provides an explanation for reversion and retrogression phenomena without recourse to nucleation concepts. (auth)

538 (TID-17020) METALLOGRAPHY OF URANIUM ELEVATED TEMPERATURES. W. N. Wise (National Lead Co. of Ohio, Cincinnati). [1961]. Contract [AT(30-1)-1156]. 12p.

Electropolished samples of U having various thermal, chemical, and fabrication histories were studied in a vacuum heating stage. Changes in the microstructure resulting from the allotropic transformations were recorded. Dilute U-base alloys were prepared, and their inclusions were examined in situ with an electron-probe x-ray microanalyzer. The effect of alpha annealing on the precipitation of U_6Fe from a dilute solution of Fe in U is shown. (auth)

539 (UCRL-10356) YIELDING AND PLASTIC FLOW OF POLYCRYSTALLINE NIOBIUM (thesis). Lenon Ivan Van Torne (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1962. Contract W-7405-eng-48. 68p.

Transmission electron microscopy techniques were used to study the process of yielding and plastic flow in polycrystalline Nb by observing the dislocation substructure resulting from tensile deformation. The tensile properties were found to vary markedly with the amount and distribution of impurity solute atoms. The amount and distribution of impurities varied with the annealing conditions. Annealing at 1000°C resulted in the formation of networks of precipitate plates in addition to solute atom clusters. Annealing at 1700 to 2100°C, resulted in a distribution of solute atom clusters 50 to 150 Å in diameter. An expression for the lower yield shear stress was obtained. (auth)

540 (UCRL-10427) INTERACTION BETWEEN PRISMATIC AND GLISSILE DISLOCATIONS. G. Saada and J. Washburn (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1962. Contract W-7405-eng-48. 20p.

A theoretical study is made of the interaction between moving dislocations and large point defect clusters in the form of Frank sessile loops and perfect prismatic loops. Long-range interactions are shown to be negligible. The contact interaction depends on the type and orientation of the loops relative to the glide plane and Burgers vector of the gliding dislocation. It is noted that perfect prismatic loops can interact with moving dislocations in four different ways. These cases are analyzed in detail. The interaction with a Frank sessile loop depends on its size. However, even loops possibly too small to be visible by transmission electron microscopy can form strong locking points on a moving dislocation. (auth)

541 (WADD-TR-60-184(Pt.III)) EFFECT OF BASIC PHYSICAL PARAMETERS ON ENGINEERING PROPERTIES OF INTERMETALLICS. J. H. Westbrook and D. L. Wood (General Electric Co. Research Lab., Schenectady, N. Y.). May 1962. Contract AF33(616)-7714. 36p.

Grain-boundary hardening is found in this investigation to exist in many intermetallic compounds having a stoichiometric excess of active metal component and is shown to be associated both with the anomalously high ductile-brittle transition temperatures common in these materials and with the "pest" phenomenon occurring in certain intermetallics. Although experiments show clearly that such grain-boundary hardening is the result of the adsorption of gaseous impurities such as O_2 and/or N_2 and their segregation to grain boundary regions, the manner in which the resistance to plastic deformation is increased in these areas is not clear. The most likely mechanism is the formation of a dislocation network as found by Ainslie et al. in Fe–S alloys. Ternary additions as well as appropriate annealing treatments are shown to be a promising approach to alleviating intergranular brittleness in these materials. (auth)

542 (WADD-TR-60-370(Pt.II)) THERMAL RADIATION PROPERTIES OF MATERIALS. PART II. R. A. Seban (California. Univ., Berkeley. Inst. of Engineering Lab.). Jan. 31, 1962. Contract AF33(616)-6630. 72p.

Spectral emittance data are presented for a number of oxidized and coated materials. These data, combined with reflectances measured at low temperature, demonstrate the relative insensitivity to temperature of such spectral properties. The specification of the Hagen Rubens equation of the spectral properties of metals is investigated by comparison with data at high and low temperatures and its usefulness is shown to be the result of a combination of photoelectric absorption and surface-stress effects. These are described, and preliminary data obtained by a system for the measurement of high-temperature sample emittance in inert gas are included. (auth)

543 (WADD-TR-60-889(Pt.II)) INVESTIGATION OF INTERMETALLIC COMPOUNDS FOR VERY HIGH TEMPERATURE APPLICATIONS. Jonathan Booker, Robert M. Paine, and A. James Stonehouse (Brush Beryllium Co., Cleveland). July 1962. Contract AF33(616)-6540. 120p.

Three different areas were studied in a continuing investigation of intermetallic beryllides and silicides for very high-temperature applications. The measured properties of Ta_2Be_{17} were unaffected by minor variations in stoichiometry between 800 and 3000°F, whereas best results for WSi_2 were obtained with a material slightly deficient in tungsten. WSi_2 exhibited poorest oxidation resistance at 2200°F. Results are reported for oxidation-rate studies on $TaBe_{12}$, $TaBe_{17}$, $ZrBe_{13}$, and Zr_2Be_{17} in the temperature range from 2300 to 2750°F. The vapor pressures for these same compounds were measured between 2300 and 2650°F using the Knudsen cell technique. For $TaBe_{12}$ the activation energy for oxidation is lower than the vaporization energy in this temperature range. The oxidation products of Zr_2Be_{17} were found to be $ZrBe_2$ and BeO. Ternary systems of beryllium and silicon with molybdenum, niobium, tantalum, tungsten, or zirconium were studied. The most promising material from these studies was a mixed-phase preparation with the stoichiometry of MoBeSi. This material exhibited less than 2 mils penetration when oxidized in air at 3000°F for 10 hours. (auth)

544 (WADD-TR-61-72(Vol.II)) RESEARCH AND DEVELOPMENT ON ADVANCED GRAPHITE MATERIALS. VOLUME II. APPLICATIONS OF ANISOTROPIC ELASTIC CONTINUUM THEORY TO DISLOCATIONS IN GRAPHITE. G. B. Spence (National Carbon Co. Research Lab., Parma, Ohio). July 1962. Contract AF33(616)-6915. 43p.

Eshelby, Read, and Shockley's theory of dislocations in an anisotropic elastic continuum was used to derive formulas not involving complex numbers for the stress-components of straight dislocations in certain symmetry directions. From these the dependence of stacking fault energy γ_F on the orientation of the Burgers vector and on the width of extended dislocations and triple partial ribbons and the dependence of γ_F on the radius of curvature of extended nodes were calculated. The results are rigorous for hexagonal crystals and approximate for general directions

in (1 1 1) planes of FCC crystals. The theory is applied to graphite and close-packed metals. All three methods of determining γ_F for graphite yield results which are compatible with the value 0.6 ± 0.2 erg/cm^2. Several examples of the dependence of width of a dislocation on depth from a stress-free surface were calculated. (auth)

545 (AEC-tr-5473) CRITICAL CURRENTS OF Nb–Zr ALLOYS IN AN EXTERNAL MAGNETIC FIELD. V. D. Borodich, A. P. Golub, A. K. Kombarov, M. G. Kremlev, N. K. Moroz, B. N. Samoilov, and V. Ya. Fil'kin (Akademiya Nauk S.S.S.R. Ordena Lenina Institut Atomnoi Energii). Translated by A. L. Monks (Oak Ridge National Lab., Tenn.). 1962. 13p.

The critical currents of Nb–Zr alloy samples of different compositions were measured in a transverse magnetic field having a voltage of 23.5 ke. Significant current anisotropy for cold-rolled sheets were detected. The effect of deformation and annealing after rolling on the superconducting properties of the alloys was studied. (auth)

546 (EURAEC-5) THE IMPROVED SINTERING OF URANIUM OXIDE WITH A VIEW TO INCREASING ITS THERMAL CONDUCTIVITY. Quarterly Report No. 1. (Compagnie Generale de Telegraphie sans Fil, Paris). June 29, 1960. Work Performed under United States–Euratom Joint Research and Development Program. Contract 004-60-3-RDF. 13p. A translation.

A review was conducted of the properties of CaO, BaO, CeO_2, La_2O_3, Y_2O_3, and Nb_2O_5 with particular attention to their use in solution, and parameters for bonding to UO_2 in solid solutions and in stoichiometric compounds. Data on the thermal conductivity of UO_2 without additives are included. (J.R.D.)

547 (EURAEC-340) BASIC STUDY OF SOME FORMS OF BRITTLENESS AFFECTING WELDED JOINTS IN HIGH-RESISTANCE STEEL. Quarterly Report No. 1, January 1–March 31, 1962. (Société des Forges et Ateliers du Creusot, Paris). Work Performed Under United States–Euratom Joint Research and Development Program. Contract 073-61-12RDF. 9p. A Translation.

Studies are being made on the embrittlement phenomena which are likely to occur in high-resistance steel welded joints. In order to eliminate certain factors which may be the cause of leakages in the tests, a casting of mild steel with low impurity content was prepared to constitute the inputs of the 50-kg high-frequency melting furnace with which the experimental castings planned in the program are prepared. Test procedures and equipment are being developed. (M.C.G.)

548 (EURAEC-341) PRESENT STATUS OF OUR KNOWLEDGE OF TEMPER BRITTLENESS. Technical Report No. 1, January 1, 1962 to March 31, 1962. Special Report No. 1. (Société des Forges et Ateliers du Creusot, Paris). Work performed under United States–Euratom Joint Research and Development Program. Contract 073-61-12RDF. 41p. A translation.

An analysis was made of data in technical literature on reversible temper brittleness. The specific characteristics of this brittleness and estimations of the embrittlement are discussed. Embrittlement kinetics are described. Factors found to modify the susceptibility of steels to embrittlement include micrographic structure and composition. Hypotheses on the nature of reversible temper embrittlement are outlined, including theory of segregations, theory of precipitates, and theory of contraction of ferrite crystals. (M.C.G.)

549 (OTS-60-51083) ASPECTS OF THE THEORY OF HEAT RESISTANCE OF METALS AND ALLOYS. K. A. Osipov. Translation of "Voprosy Teorii Zharoprochnosti Metallov i Splavov" (a publication of Publishing House of Academy of Sciences, USSR, Moscow, 1960). 254p. (PST-Cat-387)

Problems in the theory of heat resistance of metals and alloys are considered with respect to knowledge already accumulated in the field of solid-state physics, on the nature of strength and plasticity, and on the mechanism of plastic deformation and failure of crystalline solids at room and low temperatures. Another aspect of the theory of heat resistance discussed is the dependence of the mechanical properties of alloys on their composition and on the peculiarities of their phase condition and structural state. The bibliography contains 474 references. (N.W.R.)

550 DETERMINATION OF MAGNETIC ORDER IN THE FERROELECTRIC COMPOUND $BiFeO_3$ BY MEANS OF NEUTRON DIFFRACTION. S. V. Kiselev, R. P. Ozerov, and G. S. Zhdanov (Karpov Inst. of Physical Chemistry, USSR). Doklady Akad. Nauk SSSR, 145: 1255-8(Aug. 21, 1962). (In Russian)

A pressed cylindrical sample of $BiFeO_3$ 12 mm in diameter was analyzed by neutron diffraction. A special furnace was provided to take neutronographs up to temperatures of 800°C. The magnetic nature of a number of the scattering peaks was established by studying the intensities as a function of temperature. The magnetic cell was twice that of the pseudocubic elementary cell with $a_{mag} = 2a = 2 \times 3.963 = 7.926$ Å. The indices of the magnetic reflections were 111, 311, 331, and 511 + 333. An effective spin quantum number S = 1.98 was calculated from the known magnetic structure and the experimental intensity of the magnetic maximum at 111. This value is substantially lower than the value of S = ½, which is characteristic for Fe^{3+}. This study furnishes direct proof of the existence of a class of compounds which have inherent magnetic and electrical properties. (TTT)

551 THE EXPERIMENTAL DETERMINATION OF THE SURFACE TENSION OF MOLTEN NEODYMIUM. V. B. Lazarev and A. V. Pershikov (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 146: 143-4(Sept. 1, 1962). (In Russian)

Neodymium metal was purified by filtering off the oxide from the metal in vacuum by means of special vessels of beryllium and tantalum. The surface tension was obtained by determining the maximum pressure in a gas bubble. Capillary tubes and vessels of beryllium oxide were employed to minimize the corrosive attack by molten Nd. A cylindrical tantalum foil was used as a heater. Purified argon was used as the working gas. The surface tension σ of the molten Nd was found to vary from 688 dynes/cm at 1030°C to 674 dynes/cm at 1186°C. These results are about 12% higher than the theoretical value of 600 dynes/cm. (TTT)

552 TWO-WAVE SHOCK STRUCTURES IN THE FERROELECTRIC CERAMICS BARIUM TITANATE AND LEAD ZIRCONATE TITANATE. C. E. Reynolds and G. E. Seay (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys., 33: 2234-41(July 1962).

Two ferroelectric ceramics, $Pb(Zr_{0.52}, Ti_{0.48})O_3$ with 1 wt % Nb_2O_5 and pure $BaTiO_3$, were studied under shock-wave loading. Plane shock waves having pressures ranging from 2 to 175 kbar were produced by high-explosive driving systems. Measurements were made with a streak camera and shock-detecting ferroelectric wafers. Both ceramic materials showed evidence of a two-wave structure over a wide range of shock pressures. Results indicated that these two-wave structures were characteristic

of the elastic properties of the materials, and were not caused by phase transitions from ferroelectric to paraelectric. Pressure-volume curves were presented for both materials. Electrical charge released to an external load by $Pb(Zr_{0.52}, Ti_{0.48})O_3$ with 1 wt % Nb_2O_5 was measured as a function of the pressure of a shock moving parallel to the axis of polarization. The primary mechanism in this reduction of polarization by shocks was found to be, not a phase transition or domain switching, but merely a reduction of the dipole moment by axial compression. (auth)

553 CRITICAL CURRENTS OF SUPERCONDUCTING Nb 25 at.% Zr IN HIGH MAGNETIC FIELDS. Paul R. Aron and Harley C. Hitchcock (Univ. of California, Berkeley). J. Appl. Phys., 33: 2242-4(July 1962).

Measurements of critical current as a function of applied magnetic field are made on wire samples of Nb–25 at.% Zr alloy at 4.22 and 2.24°K. Curves are plotted for the cases for which the applied magnetic field is parallel or perpendicular to the current direction. At 4.22°K, $H_c(I \rightarrow 0)$ for H perpendicular to I is found to be 70 kG, while for H parallel to I, it is found to be 82 kG. Reduction of the temperature to 2.24°K results in an increase of 13 kG in both cases. For H perpendicular to I, current densities of 4.4×10^4 amp/cm^2 are observed at 60 kG and 4.22°K, and at 73 kG and 2.24°K. The effective demagnetization factor of the current-carrying elements is 0.6 π. All measurements are made in a d-c magnetic field with quasi-direct currents by observation of the first resistive voltage to appear across the sample. (auth)

554 A DUCTILE, HIGH-FIELD, HIGH-CURRENT TERNARY SUPERCONDUCTING ALLOY. R. M. Rose and J. Wulff (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 33: 2394(July 1962).

The critical currents and ductilities of alloys containing 25 at.% Zr; 2, 5, or 10 at.% Ta; and the balance of Nb are determined. The effects of processing variables (such as cold-swaging) on the superconducting properties are noted. Specimens containing 5 at.% Ta are found to have critical currents greater than 10 amp and critical current densities greater than 10^4 amp/cm^2 for magnetic fields in excess of 90 kOe. (T.F.H.)

555 HIGH-TEMPERATURE ELECTRICAL CONDUCTION IN THE SYSTEM UO_2-ZrO_2. H. A. Johansen and J. G. Cleary (Westinghouse Electric Corp., Pittsburgh). J. Electrochem. Soc., 109: 1076-9(Nov. 1962).

A method for determining the a-c electrical conductivity of ceramic oxides to 2000°C in neutral atmosphere is described. The electrical conduction of the system UO_2-ZrO_2 is investigated. All compositions of $(UO_2)_x(ZrO_2)_{1-x}$, where $0.1 \leq x \leq 0.9$, show two modes of conduction: a low-temperature region below about 1100°C with an activation energy of 0.26 ev, and a high-temperature region with an activation energy of about 1.59 ev. (auth)

556 ZIRCONIUM–NIOBIUM PHASE DIAGRAM. Yu. F. Bychkov, A. N. Rozanov, and D. M. Skorov. Met. i Metalloved. Chistykh Metal., Sb. Nauchn. Rabot, No. 1, 179-91(1959).

X-ray, thermal, dilatometric, thermal-elastic and metallographic methods were employed to study transformations and to plot a phase diagram of the Zr-Nb system. The alloys investigated were melted in an arc furnace in argon atmosphere from a Nb-strip of iodide Zr rods of 99.7% purity. After 3 to 5 fold remelting the ingots were forged at 800 to 600°C and subjected to heat treatment. It was established that in the Zr-Nb system at high temperatures a continuous series of solid solutions are formed between β-Zr and Nb with a minimum on the solidus curve at 1,600°C and 30% Nb. At 560°C, the eutectoid decomposition of β-solid solutions took place. The eutectoid point corresponded to 12% Nb. During the quenching of alloys containing up to 15% Nb, the β-solution was partially or fully transformed into acicular or reticular martensite-like structure. In alloys with 15% and more Nb, a body centered cubic β-phase appeared during quenching from high temperatures. (Ref. Zh. Met., No. 12, 1961)

557 RADIOGRAPHIC AND RADIOMETRIC INVESTIGATION OF CAST IRON MODIFIED WITH SPHEROIDAL GRAPHITE. A. P. Lyubchenko, Yu. G. Bobro, and M. V. Mozharov. Metalloved. i Term. Obrabotka Metal., No. 8, 15-17(Aug. 1962). (In Russian)

There is no satisfactory theory at present on the crystallization of graphite in nodular cast iron containing Mg or Ce because the available data are insufficient. Studies were made therefore on the distribution of Ce in the highly resistant nodular cast iron containing Ce and Mg additives and making use of Ce^{144} as tracer. The subeutectic alloy and the graphite were heated together, adding Ce^{144} to the melt; the specific activity of the resulting material was about 1 microcurie. Autoradiographic tests with 40 to 60-micron thick layers made it possible to estimate the distribution of the Ce between the graphite and the metallic matrix; it was found to concentrate preferentially in the center of the graphite grains. The metallic phase contained more of it than the periphery of the graphite grains. X-ray diffraction studies confirmed that the insoluble portions consist of graphite. The coherent scattering region of the graphite was found to be between 10^{-4} to 10^{-6} cm. The Ce acted as a strong surface-active material with respect to C. Growth of the graphitic crystallite was determined from the volume change rate of the pores due to the "crystallization" of vacancies. All the observed phenomena facilitate the formation of spheroidal graphite. (TTT)

558 STRUCTURAL CHANGES DURING THE HEATING OF COLD-DRAWN STAINLESS STEEL. L. A. Dolinskaya and S. Z. Nekrasova (Scientific Research Inst. of Turbine Construction, Ukrainian, SSR). Metalloved. i Term. Obrabotka Metal., No. 8, 22-4(Aug. 1962). (In Russian)

The beginning and the end of the recrystallization and other structural changes of the cold-drawn steel No. Kh18N9T (corresponding to the U. S. 321 type) were investigated in the temperature range from 600 to 1200°C. The original structure containing finely drawn grains underwent an abnormal grain growth after being kept at 600 to 750°C for 3 hours and exhibited increased corrodability. The increase of the grain dimensions was followed by recrystallization starting at 750°C; recrystallized grains with curved boundaries spread throughout the metal by 800°C. Upon further heating, the original equiaxial crystals were reconstituted but heated beyond 1050°C new grain growth was observed as the result of selective crystallization. X-ray diffraction studies yielded higher values for the beginning and the end of the recrystallization process than the metallographic tests. (TTT)

559 PHASE COMPOSITION AND PROPERTIES OF NITROGEN-CONTAINING AUSTENITIC STEELS. I. S. Rubel', M. M. Brilakh, and V. P. Sadovnichii (Sverdlovsk). Metalloved. i Term. Obrabotka Metal., No. 8, 40-3(Aug. 1962). (In Russian)

The effect of short, 5 to 10 minutes, and long, 1 to 3 hours, heating periods on the structure of N-containing austenitic steels was investigated paying special attention to the $\delta \rightarrow \sigma$ transformation after repeated heat treat-

ments following quenching and under isothermal conditions. The σ phase was quantitatively determined by measuring the decrease of the ferromagnetic component in the test specimens. Study of the kinetic curves indicated that the startup and the intensity of the $\delta \rightarrow \sigma$ transformation depend greatly on the soaking temperature: as the temperature increased from 600 to 800 or 850°C, the rate of the transformation reaction increased. The upper limit of the σ phase determined by isothermal heat treatment was found to lie below 1000°C. The new phase thus formed is hard and brittle, reducing greatly the overall toughness of the metal; therefore only tempered materials of these steel types should be used if the fabricated goods might be exposed to heat during usage or during welding operations. (TTT)

560 THE LOCATION OF GRAIN BOUNDARIES IN CASE OF RECRYSTALLIZATION. S. Z. Bokshtein, M. B. Bronfin, S. T. Kishkin, and L. M. Moroz. Metalloved. i Term. Obrabotka Metal., No. 9, 6-8(Sept. 1962). (In Russian)

It was established earlier (Zavodskaya Laboratoriya, No. 10 (1960)) that during the heating of deformed metals the atoms of the grain boundary remain at their former location. This observation was further confirmed by making use of radioactive isotopes. The behavior of C, P, S, Si, Al, Mn, Ni, and Cu impurities at the grain boundary during the recrystallization of Fe was investigated by a method involving autoradiography and microstructural analysis. The impurity atoms were introduced by diffusion saturation of the specimens at temperatures ranging from 600 to 700°C. Tests were also made with radioactive W^{185} in Mo–Zr alloys. Results indicated that the impurity atoms remain at their old location in spite of the great structural changes which take place in the metal during the annealing period. Both autoradiography and microstructural studies revealed that the accelerated migration of atoms followed a preferential path alongside the former grain boundary. It was concluded that shifting of the grain boundary generates a much higher concentration of defects at the starting and final point of the boundary shift than in the volume of the grains. (TTT)

561 STRUCTURAL CHANGES IN STEELS CAUSED BY INTERACTION WITH HIGH-TEMPERATURE COMPRESSED GAS STREAMS. B. D. Grozin, S. B. Nizhnik, and V. F. Yankevich (Inst. of Mechanics, Academy of Sciences, Ukrainian SSR). Metalloved. i Term. Obrabotka Metal., No. 9, 13-16(Sept. 1962). (In Russian)

In order to determine the properties of surface layers formed on steels, the interaction between the metal and high-temperature, high-pressure gases was investigated. The gas mixture was obtained from the burning of smokeless powder; its pressure reached 1300 kg/cm^2 for the duration of 0.0025 sec. A thin surface layer of the metal was heated during the rapid burning to 900 to 1000°C at a rate of 3 to 400,000°C/sec. Spectrographic analysis of the surface layer revealed that C and N from the gas phase diffused into the metal to a depth of 10 microns, forming a nitrided and carbided austenitic phase. The thickness of the whitish layer was found to decrease as the annealing temperature of the steel was increased. The phase composition of the layer formed under high pressure and at high temperature was found to possess different crystal lattice parameters and presented a different dispersion of the carbide phase than the ordinary annealed metal. (TTT)

562 STRUCTURAL CHANGES ORIGINATING DURING THE ANNEALING OF EUTECTIC CARBON STEELS. O. A. Bannykh, Kh. Modin, and S. Modin (Baikov Inst. of Metallurgy and Metallurgical Inst., Stockholm). Metalloved. i Term. Obrabotka Metal., No. 9, 17-19(Sept. 1962). (In Russian)

The carbide phase of hardened and annealed steel specimens containing 0.83% C was studied by electron diffraction methods. It was found that as a result of annealing at 200°C for 100 hours, at 300°C for 20 seconds, and at 400°C for 10 seconds the orthorhombic cementite lattice could not be observed. However, after longer soaking periods at the 2 higher temperatures for longer periods of time, in addition to the cementite, the presence of ε-carbide could also be established; after further increase of the soaking time and temperature, only the cementite remained in the system. The carbide had a tendency of forming layers; the crystalline precipitates in the grains were oriented in 1 or 2 directions. At 400°C spheroidization took place, conserving the orientation of the particles. At 500°C the ferrite matrix recrystallized and the orientation of the carbide particles disappeared. Upon further increase of the temperature to 600 and 700°C the carbide particles at the grain boundary of the ferrite continued to grow while the particles within the grains were dissolved. Annealing at 700°C for 20 hours resulted in the concentration of all the carbide precipitates at the grain boundaries. (TTT)

563 THE NATURE OF THE 475°-EMBRITTLEMENT OF STAINLESS STEEL. N. I. Kopersak (Polytechnic Inst., Kiev). Metalloved. i Term. Obrabotka Metal., No. 9, 34-40 (Sept. 1962). (In Russian)

Exposure of chrome stainless steels to extended soaking at temperatures between 425 and 525°C results in the decrease of the plasticity, toughness, specific resistivity, and corrosion resistance of the metal. The nature of this so-called 475°C (885°F) embrittlement was investigated on a steel containing 27.80% Cr and 9.70% Ni by means of microhardness measurements and metallographic studies. It was found that there is a basic difference between the 475°C embrittlement and cold short brittleness: the latter occurs at higher temperatures. It is concluded that the 475°C embrittlement cannot be attributed to the precipitation of an excess brittle phase. It is due to σ aging, a preliminary stage of the σ-phase formation. The wide distribution of the internal phase causes lattice distortion, resulting in the phase-hardening of the ferrite. This is responsible for the sudden decrease of the toughness, the increase of the microhardness, and other changes in the physical properties of the metal. (TTT)

564 RESEARCH ON THE SYSTEMS THORIUM–TUNGSTEN–CARBON AND URANIUM–TUNGSTEN–CARBON. Erwin Rudy, Elisabeth Rudy, and F. Benesovsky (Metallwerk Plansee AG., Reutte, Tirol, Austria). Monatsh. Chem., 93: 522-35(Apr. 20, 1962). (In German)

The three-component Th–W–C and U–W–C sintered and luminous-arc-melted alloys were investigated by x-ray spectroscopy and metallography. A phase distribution diagram was undertaken. Thorium dissolved approximately 6 at.% carbon by lattice expansion (to a = 5.12 A). The region of ThC reached, at 1500°C, from 38 to 50 at.% C (a = 5.30 to 5.34 A). In the system Th–W–C no ternary phases appeared; the equilibrium was determined by means of the combinations of the boundary systems. In the system U–W–C the previously found ternary phase UWC_2 and its structure (a = 5.633 A, b = 3.255 A, and c = 10.98 A) were confirmed. In the compound UWC_2 no noticeable exchange of uranium for thorium was observed. The solubility regions were small in both systems. On the basis of observed reactions the free formation enthalpy for ThC_2

(−32 to −23.3 kcal/mol) and UWC_2 (−37.7 to 41.2 kcal/mol) could be calculated. (tr-auth)

565 EFFECTS OF ALLOYING ADDITIONS ON THE $\alpha \rightleftharpoons \gamma$ TRANSFORMATION OF CERIUM. PART II. EFFECTS OF SCANDIUM, THORIUM AND PLUTONIUM ADDITIONS. K. A. Gschneidner, Jr., R. O. Elliott, and R. R. McDonald (Los Alamos Scientific Lab., N. Mex.). Phys. and Chem. Solids, 23: 1191-9(Sept. 1962). (LADC-5282)

Some influences of scandium, thorium, and plutonium additions to cerium on the $\alpha \rightleftharpoons \gamma$ transformation were studied. It was learned that valency of the solute has important influence on this transformation, that these solutes prevent the formation of the β-Ce, and that the heat of transformation is increased by scandium and plutonium and decreased by thorium. Furthermore, it was found that the critical point of pure cerium is lowered considerably by thorium additions. (auth)

566 EFFECTS OF ALLOYING ADDITIONS ON THE $\alpha \rightleftharpoons \gamma$ TRANSFORMATION OF CERIUM. PART III. EFFECTS OF YTTRIUM AND RARE EARTH ADDITIONS. K. A. Gschneidner, Jr., R. O. Elliott, and R. R. McDonald (Los Alamos Scientific Lab., N. Mex.). Phys. and Chem. Solids, 23: 1201-8(Sept. 1962). (LADC-5283)

The influence of yttrium and of the rare earth metals on the electronic ($\alpha \rightleftharpoons \gamma$) transformation of cerium at high pressures and at low temperatures was studied. It was shown that the size of the solute atom is important both at high pressures and at low temperatures, and that the spin of the unpaired $4f$ electron(s) of the solute atom is important only for the $\gamma \rightarrow \alpha$ transformation at low temperatures. The reverse transformation ($\alpha \rightarrow \gamma$) at low temperatures appears to be dependent only on the size of the solute atom. It was also found that yttrium and most of the rare earths, with the exception of europium and ytterbium, are β-Ce stabilizers. (auth)

567 THERMAL CONDUCTIVITY OF SUPERCONDUCTORS. K. D. Chaudhuri (Univ. of Delhi). Phys. and Chem. Solids, 23: 1341(Sept. 1962).

A plot of the logarithm of the thermal conductivity of superconducting V vs T_c/T gives a straight line up to $T_c/T = 2.3$, indicating that the equation K_s = constant x $\exp(-\beta T_c/T)$ holds true for V. Straight lines were also found for Nb and Re crystals. (D.L.C).

568 SUPERCONDUCTIVITY OF CHROMIUM ALLOYS. B. T. Matthias, T. H. Geballe, V. B. Compton, E. Corenzwit, and G. W. Hull, Jr. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 128: 588-90(Oct. 15, 1962).

The superconducting properties of Cr−Ru, Cr−Rh, and Cr−Ir alloys were investigated and the transition temperatures were determined as a function of composition and of valence-electron concentration. The Cr−Ru system contains three superconducting phases all of which have a homogeneity range. A hexagonal close-packed alloy containing 50 at. % Cr has a transition temperature of 1.65°K. The sigma-phase type compound Cr_2Ru has a transition temperature of 2.0°K and Cr_3Ru which crystallizes in the β-W type structure becomes superconducting at 3.3°K. The hexagonal close-packed alloys in the Cr−Rh system are superconducting. The transition temperature of an alloy containing 70 at. % Cr is 1.1°K. Weak ferromagnetism was observed in cold-worked hexagonal close-packed alloys containing approximately 60 at. % Cr. There are two superconducting phases in the Cr−Ir system. A hexagonal close-packed alloy containing 72 at. % Cr has a transition temperature of 0.83°K. An alloy with the β-W type structure containing 85 at. % Cr becomes superconducting at 0.77°K. Both superconductivity and ferromagnetism occur in the Cr−Ir system. The critical conditions for the occurrence of both phenomena are discussed. (auth)

569 LATTICE DYNAMICS OF BERYLLIUM. R. E. Schmunk, R. M. Brugger, P. D. Randolph, and K. A. Strong (Phillips Petroleum Co., Idaho Falls, Idaho). Phys. Rev., 128: 562-73(Oct. 15, 1962).

Measurements of the dispersion relations for waves propagating in the [0001] and [01$\bar{1}$0] directions in beryllium have been made using the MTR phased-chopper slow-neutron velocity selector. In the [01$\bar{1}$0] direction only one of the transverse modes was available for investigation, that having atom displacement normal to the basal plane. Two distinct frequencies were observed at the center of the Brillouin zone for the optical branches, and the corresponding branches are referred to as upper optical and lower optical. For both symmetrical directions, the upper optical branch corresponds to the mode of vibration having the polarization vector parallel to the hexagonal axis. Pertinent frequencies in units of 10^{13} sec^{-1} are: (at the center of the zone) upper optical, 1.99 ± 0.07; lower optical, 1.33 ± 0.04; (at the zone boundary in the [0001] direction) lower optical and transverse acoustical, 1.01 ± 0.06; upper optical and longitudinal acoustical, 1.57 ± 0.07; (at the zone boundary in the [01$\bar{1}$0] direction) upper optical, 1.69 ± 0.09; lower optical, 1.63 ± 0.08; longitudinal acoustical, 1.54 ± 0.08; transverse acoustical, 1.21 ± 0.05. The mode of vibration for a particular phonon was determined from the region of reciprocal space in which the transition was observed. The initial slopes of the acoustical branches agree well with elastic constant data, except for the longitudinal branch in the [0001] direction. Lattice dynamics models of Begbie and Born and of Slutsky and Garland, the latter extended to include interactions with fourth and fifth nearest neighbors, give limited agreement with the present data only when the force constants in the models are evaluated from the neutron-scattering data. (auth)

570 SPECIFIC HEAT OF TERBIUM METAL BETWEEN 0.37 AND 4.2°K. O. V. Lounasmaa and Pat R. Roach (Argonne National Lab., Ill.). Phys. Rev., 128: 622-6(Oct. 15, 1962). (TID-16630)

The specific heat C_p of terbium metal, measured between 0.37 and 4.2°K in a He^3 cryostat, could be separated by a least squares analysis into three contributions: the lattice specific heat $C_L = 0.58\ T^3$ (corresponding to a Debye $\theta = 150$°K), the electronic specific heat $C_E = 9.05$ T, and the nuclear specific heat $C_N = 238\ T^{-2} - 11.9\ T^{-3} - 4.5\ T^{-4} + 0.38\ T^{-5} + 0.06\ T^{-6}$ (C_p in mJ/mole °K). C_N is due to the splitting of the nuclear spin states by the magnetic field H_{eff} of the $4f$ electrons and by the nuclear electric quadrupole coupling. In the series expansion for C_N there are only two independent constants, the magnetic hyperfine constant a′ and the quadrupole coupling constant P. Our experimental values of a′ = 0.150°K and P = 0.021°K are in good agreement with results obtained by electron paramagnetic resonance and nuclear magnetic resonance techniques which gave a′ = 0.152°K and P = 0.029°K. By assuming μ = 1.52 nuclear Bohr magnetons for Tb^{159} one obtains $H_{eff} = 4.1$ MG. In sharp contrast with earlier results, our measurements revealed no anomalies in C_p between 1 and 4°K. Such anomalies thus were probably caused by impurities in the samples of the other investigators. (auth)

571 INFLUENCE OF ELECTRON INTERACTIONS ON METALLIC PROPERTIES. I. SPECIFIC HEAT. S. D. Silverstein (Univ. of Illinois, Urbana). Phys. Rev., 128: 631-7(Oct. 15, 1962).

The specific heat of an intermediate density electron gas has been calculated by the use of a momentum-transfer interpolation procedure analogous to that used by Nozières and Pines in the calculation of the correlation energy. The explicit momentum transfer dependence of the derivative of the self-energy at the Fermi surface has been calculated in the long-wavelength limit by the use of the random-phase approximation, and in the short-wavelength limit by the use of second-order perturbation theory with the neglect of parallel-spin interactions. The contributions from the intermediate momentum transfer interactions are determined by a smooth interpolation between the short- and long-range regions. The results obtained by this procedure are in excellent accord with the high-density results for $r_s \sim 1$, and in their application to the alkali metals predict the experimentally observed enhancement of the specific heat ratio. (auth)

572 NUCLEAR MAGNETIC RESONANCE IN UAl_2. A. C. Gossard, V. Jaccarino, and J. H. Wernick (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 128: 1038-43(Nov. 1, 1962).

The nuclear magnetic resonance of Al^{27} in UAl_2 has been observed in the range of temperatures 4-300°K. Large Knight shifts (K) were found with a temperature dependence not of a Curie-Weiss type. This behavior and the temperature independence of the linewidth, when considered in conjunction with susceptibility (χ) measurements, indicate (1) no localization of the magnetization of the U (5f and/or 6d) electrons and (2) no magnetic ordering exists. These results are contrasted with those obtained on the isostructural XAl_2 (X = rare-earth ion) metals. Using a simple model, certain features of the band structure and the effective exchange interaction between itinerant f and s electrons may be deduced. From the extrapolated limit of the linear K vs χ curve a large positive temperature-independent contribution to χ is obtained which is attributable to the Kubo-Obata orbital paramagnetism to be expected in metals with unfilled degenerate bands. (auth)

573 IMPERFECTION PHOTOCONDUCTIVITY IN DIAMOND. J. A. Elmgren and D. E. Hudson (Ames Lab., Ames, Iowa). Phys. Rev., 128: 1044-53(Nov. 1, 1962). (IS-370)

The effect of monochromatic light throughout the visible region on the rate of decay of a persistent internal field in diamond has been studied. The persistent field was generated by spacially-separated trapped electrons and holes, and was sampled by the counting rate of the polarized diamond acting as a nuclear particle counter. Under the influence of light the internal field decayed exponentially with time in a fashion characterized by an intensity-dependent decay constant. The decay constants, normalized to a common photon flux density, varied over more than four orders of magnitude in the photon energy range from 1.8 to 3.5 ev. The results are interpreted in terms of imperfection photoconductivity arising from imperfection levels with photoionization energies of 2.5 and 3.0 ev. This photoconduction model utilizes a decay mechanism which has been overlooked in previous diamond work. An alternate conventional interpretation in terms of detrapping is also presented. (auth)

574 CRYSTAL DYNAMICS OF LEAD. I. DISPERSION CURVES AT 100°K. B. N. Brockhouse, T. Arase, G. Caglioti, K. R. Rao, and A. D. B. Woods (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev., 128: 1099-1111(Nov. 1, 1962).

Frequency/wave vector $\nu(q)$ dispersion curves for lead at 100°K have been measured by neutron spectrometry along the lines [ζ00], [$\zeta\zeta\zeta$], and [ζ10] in the reduced zone. The experiments were performed with the triple-axis crystal spectrometer, making extensive use of the "constant Q" method. The results show many interesting features. The dispersion relations have local minima at the point (1,0,0), leading to extra critical points in the frequency distribution. The dispersion curves are analyzed into Fourier components (within the estimated errors), according to the equation $M\omega^2 = \Sigma_{n=1}^{N} \Phi_n[1 - \cos(\pi nq/q_M)]$ with $N \leq 12$. The existence of high Fourier components is definitely established. These high Fourier components imply the existence of very long range forces between the atoms in lead. In some cases the forces are of alternating sign. The dispersion curves show small anomalies which are believed to arise from the effect predicted by Kohn. The positions in reciprocal space at which these anomalies occur agree well with the quasi-free model for the electrons in lead, proposed by Gold. In the [111] direction (extended zone scheme) the Fermi radius is less than 1% greater than the free electron value of $1.24(2\pi/a)$; in the [110] direction the Fermi radius is $(1.19 \pm 0.01)\ (2\pi/a)$. The Kohn effect is discussed in terms of theoretical work of Bardeen and Toya and the reasons for its observability in Pb are elucidated. (auth)

575 CRYSTAL DYNAMICS OF SODIUM AT 90°K. A. D. B. Woods (Atomic Energy of Canada Ltd., Chalk River, Ont.), B. N. Brockhouse, R. H. March, A. T. Stewart, and R. Bowers. Phys. Rev., 128: 1112-20(Nov. 1, 1962).

The frequency/wave vector dispersion relations for the lattice vibrations of sodium have been measured by neutron spectrometry along the symmetric lines [00ζ], [$\zeta\zeta$0], [$\zeta\zeta\zeta$], [$1/2\ 1/2\ \zeta$], and [$\zeta\zeta$1] and at several nonsymmetric points in the reduced zone. The measurements were made at 90°K using the triple-axis crystal spectrometer in the constant Q mode of operation. The results can be qualitatively described by a first- and second-neighbor force model but detailed analysis shows that fourth- and fifth-neighbor forces are probably significant. The calculated force constants for fifth neighbors are about 1 or 2% of those for first neighbors. Discontinuities in the slopes of the dispersion curves due to the Fermi surface (the Kohn effect) were not observed. (auth)

576 LATTICE VIBRATIONS IN PYROLITIC GRAPHITE. G. Dolling and B. N. Brockhouse (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev., 128: 1120-3(Nov. 1, 1962).

The dispersion relation for the longitudinal acoustic lattice waves propagating in the direction of the hexad axis in (pyrolitic) graphite, at room temperature, has been determined by neutron spectrometry. The dispersion curve has very closely the form of a sine curve, with a maximum frequency of $(3.84 \pm 0.06) \times 10^{12}$ cps, for the zone-boundary phonon of wavelength c = 6.70 Å. The transverse acoustic lattice waves were less well determined, but show roughly similar behavior with a maximum frequency at the zone boundary of $(1.3 \pm 0.3) \times 10^{12}$ cps. Values for certain elastic constants have been deduced from the measurements: in units of 10^{11} dyn/cm^2, $C_{33} = 3.9 \pm 0.4$, and $C_{44} = 0.42 \pm 0.2$. (auth)

577 SPECIFIC HEAT OF HOLMIUM METAL BETWEEN 0.38 AND 4.2°K. O. V. Lounasmaa (Argonne National Lab., Ill.). Phys. Rev., 128: 1136-9(Nov. 1, 1962). (TID-16629)

Between 0.38 and 4.2°K, the specific heat of holmium metal can be expressed $C_p = 2.26T^3 + 10T + C_N$ (in mJ/mole °K). For calculating the nuclear specific heat C_N a Schottky curve for eight energy levels at $W_i/k = a'i + P[i^2 - \frac{1}{3}I(I+1)]$, where $i = -7/2, \cdots, 7/2$, must be used.

The magnetic hyperfine constant a′ = 0.320°K and the quadrupole coupling constant P = 0.007°K. The results below 1°K indicate that a quadrupole term is necessary for representing the data with a Schottky curve. At 0.29°K, where the maximum is reached, C_N = 7000 mJ/mole °K and even at 4°K C_N = 269 mJ/mole °K, being thus larger than the other contributions to C_p combined. The effective magnetic field at the holmium nuclei is 9.3 MG. Owing to the very large hyperfine interaction the coefficient of the electronic specific heat was obtained from measurements on other rare earths. The T^3 term is the sum of lattice and magnetic specific heats and it was calculated from the present results above 2°K. The magnetic heat capacity apparently depends on the thermal history of the metal or on impurities. (auth)

578 STRUCTURE INVESTIGATIONS IN SOME SYSTEMS QUASI-HOMOLOGOUS AND HOMOLOGOUS TO T^4-B^1. Erich Stolz and Konrad Schubert (Max-Planck-Institut für Metallforschung, Stuttgart). Z. Metallk., 53: 433-44 (July 1962). (In German)

In the systems Ti–Au, Zr–Au, and Hf–Au the following structures and translation groups were determined: $TiAu_4$ ($MoNi_4$ type), $TiAu_2$ ($MoSi_2$ type), TiAu(h) (AuCd type), TiAu(r) (TiCu(Ti) type); $ZrAu_4$ ($ZrAu_4$ type), $ZrAu_3$ ($TiCu_3$ type), $ZrAu_2$ ($MoSi_2$ type), Zr_7Au_{10} (tetragonal body-centered cell), Zr_2Au (C11b′ type); $HfAu_5$ ($MoNi_4$ type), $HfAu_4$ ($ZrAu_4$ type), $HfAu_3$ ($TiCu_3$ type), $HfAu_2$ ($MoSi_2$ type), Hf_7Au_{10} (tetragonal body-centered cell), HfAu(r) (TiCu(Ti) type), and Hf_2Au (C11b′ type). In the systems V–Au, Cr–Au, Mn–Au, and Zr–Pd the following structures were found: VAu_4 ($MoNi_4$ type), VAu_2 (orthorhombically distorted cell similar to that of $MoSi_2$; an approximate structure is presented); $CrAu_4$ ($MoNi_4$ type); $MnAu_2$ ($MoSi_2$ type), MnAu(Mn) (B2 orthorhombically distorted), Mn_2Au ($MoSi_2$ type); $ZrPd_2$ ($MoSi_2$ type), and Zr_2Pd (C11b′ type). The phases being in equilibrium with the present phases were determined. The observed structures were described and their relations considered. (auth)

579 PALLADIUM AND PALLADIUM ALLOYS FOR THE PREPARATION OF HIGH-PURITY HYDROGEN. Guenther Friedrich Paul Mueller (W. C. Heraeus G.m.b.H., Hanau, Ger.). Z. Metallk., 53: 449-53(July 1962). (In German)

Hydrogen solubility and diffusion in palladium and Pd alloys together with the construction of high capacity diffusion cells for the technical preparation of high-purity hydrogen and the separation of hydrogen from other gases were investigated. The dependence of the diffusion on various physical parameters is discussed. New test results on the change of electrical resistance and on the hydrogen pick-up of Pd during temperature rise and on thermal cycling are described. Investigations in the purity of the diffused hydrogen are discussed. (auth)

580 CONDUCTIVITY AND HALL CONSTANTS. XXIII. THE TEMPERATURE DEPENDENCE OF THE RESISTANCE AND THE HALL CONSTANT OF PALLADIUM MIXED CRYSTALS. Werner Gmoehling and Dieter Hagmann (Max-Planck-Institut für Metallforschung, Stuttgart). Z. Metallk., 53: 459-65(July 1962). (In German)

The temperature coefficient of resistivity and Hall constant at room temperature were measured on alloys of Pd with Ag, Cd, In, Rh, Ru, Mo, Nb, Zr, and V. Starting from pure Pd, the absolute temperature coefficient of resistivity $\Delta_q/\Delta T$ is decreased by all alloying additions. This fact is mainly due to the filling up of the d-band by the electrons of the solute. The amount of the absolute temperature coefficient of the Hall constant $\Delta R/\Delta T$ also decreases in every case. This change is far more pronounced than that of the temperature coefficient of resistivity and leads to a change of sign for many alloys at additions of only 2 at.% alloying element to Pd. This effect is also connected with the d-band of Pd. Comparing it with the behavior of the thermoelectric power of these alloys, however, suggests that this pronounced change is mainly caused by the scattering of the electrons at solute atoms. (auth)

581 THE PLASTIC BEHAVIOR OF NICKEL–COBALT SINGLE CRYSTALS. II. STACKINGFAULT ENERGY, SURFACE OBSERVATIONS, SLIP PROCESSES AND RECOVERY PROCESSES. Fritz Pfaff (Max-Planck-Institut für Metallforschung, Stuttgart and Technische Hochschule, Stuttgart). Z. Metallk., 53: 466-73(July 1962). (In German)

The slip line pattern of the surface of Ni–Co single crystals with 50 and 60 at.% Co was investigated by electron microscopy during a deformation tensile test. Some results of mechanical tests on these crystals are thoroughly discussed. The slip line parameter was derived from slip lines caused by plastically sheared screw dislocations and the work-hardening coefficient of stages I and II was calculated. The values lie below the ones derived from the work-hardening curves. Rate change tests on Ni40Co60 in stage I and the beginning of stage II resulted in an activation volume of 2.74×10^{-20} cm^3 and in a surface density of forest dislocations of 93×10^{-8} cm^{-2} for edge and 6×10^{-8} cm^{-2} for screw dislocations. The experimentally developed equation $\ln a_{II}^{(r)}(T) = \ln a_{II}^{(r)}(0) - D \cdot T$ represents stage I at not too low temperatures. The factor D depends on the stacking-fault energy in the same way as can be qualitatively explained from theory. The stacking-fault energy of Ni50Co50 as $(10^3 \gamma/G_0 b) = 3.1$ was derived from the temperature-dependent τ_{III}, at medium temperatures. Slip lines of dislocations with a predominantly edge contribution indicated that at high temperatures the dynamic softening in stage III is caused by the climbing of edge dislocations. The temperature at which this climbing starts depends on the stacking-fault energy. The fanning of the slip lines due to the climbing is only small because of the high activation energy of the vacancy self-diffusion. A static recovery in stage III is possible at high temperatures. The increase of the work-hardening coefficient with the deformation during the recovery is possibly caused by loops formed through dislocation condensation. (auth)

582 THE STRUCTURE OF SYSTEMS HOMOLOGOUS AND QUASI-HOMOLOGOUS TO T^4-B^3. I. THE SYSTEMS TITANIUM–GALLIUM, ZIRCONIUM–GALLIUM, AND HAFNIUM–GALLIUM. Manfred Poetzschke and Konrad Schubert (Max-Planck-Institut für Metallforschung, Stuttgart). Z. Metallk., 53: 474-88(July 1962). (In German)

The phase diagrams of the systems Ti–Ga, Zr–Ga, and Hf–Ga were determined and the structures of the intermetallic compounds were revealed. (auth)

583 INVESTIGATION OF THE THERMODYNAMIC PROPERTIES OF CADMIUM–INDIUM ALLOYS. G. V. Pozharskaya and A. M. Evseev (Moscow State Univ.). Zh. Fiz. Khim., 36: 1053-4(May 1962). (In Russian)

Thermodynamic activity of Cd in Cd–In alloys was determined at 543 to 583°K, and the thermodynamic functions were calculated. The enthalpy and entropy of liquid alloy formation are discussed. (R.V.J.)

584 SPLAVY, TORIYA, URANA I PLUTONIYA. SBORNIK MATERIALOV PO DIAGRAMMAM SOSTOYANIYA I KRISTALLICHESKIM STRUKTURAM. (Thorium, Ura-

nium, and Plutonium Alloys. Symposium of Papers on Constitution Diagrams and Crystal Structures). V. I. Kutaitsev. Moscow, Gosatomizdat, 1962. 224p.

Reference data are collected on reactions of fissionable metals with various elements. Short descriptions are given of the physical properties (allotropic transformation temperature, crystal structure, and melting points) and constitution diagrams of two and three component alloys at various temperatures. The first and second parts of the book consist of corrected and expanded data from the book published by R. Rough and A. Bauer, Constitution Diagrams of Uranium and Thorium Alloys. The third part consists of papers presented at the Geneva Conference and other published articles. (R.V.J.)

585 METALS HANDBOOK, 8TH EDITION. VOLUME I. PROPERTIES AND SELECTION OF METALS. Taylor Lyman, ed. Novelty, Ohio, American Society for Metals, 1961. 1312p.

Data and practical information are presented for metals and subdivided into the following sections: carbon and low-alloy steels; cast irons; stainless steels and heat-resisting alloys; tool materials; magnetic, electrical, and other special-purpose materials; aluminum and its alloys; copper and its alloys; lead and its alloys; magnesium and its alloys; nickel and its alloys; tin and its alloys; titanium and its alloys; zinc and its alloys; precious metals; and properties of pure metals. (D.L.C.)

586 IMPROVEMENTS IN ZIRCONIUM ALLOYS. Geoffrey Charles Edward Olds and John Edwin Harris (to Associated Electrical Industries Ltd.). British Patent 906,638. Sept. 26, 1962.

A Zr alloy which has both high corrosion resistance to CO_2 and high creep strength comprises 0.25 to 3% Cu, 0.25 to 5% Al, 0.25 to 5% Nb, and balance Zr. The preferred composition is 0.5 to 2% Cu, 1 to 3% Al, 1 to 3% Nb, and balance Zr. The effects of additions of 2% each of Al and Nb on the creep strength of Zr–1% Cu alloy are shown. (D.L.C.)

Radiation Effects

587 (GEAP-4067) MARITIME LOOP IRRADIATION PROGRAM. SAVANNAH I FUEL IRRADIATION QUARTERLY PROGRESS REPORT, APRIL 1–JULY 31, 1962. D. W. Danielson (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Aug. 17, 1962. Contract AT (04-3)-189. 20p.

Details concerning the S-I-5-B-M fuel irradiation during the period are reported. A summary of the data concerning these irradiations is included. It is noted that individual cycle reports #14, 15, 16, and 17 present significant data on loop operation parameters and water chemistry data. The loop operated continuously during reactor operation for the period. All water chemistry conditions with the exception of dissolved H_2 were maintained within specifications during reactor operation. The S-I-5-B-M fuel was removed after GETR shutdown, thus concluding the fuel irradiation test. (J.R.D.)

588 (GEMP-16A) HIGH-TEMPERATURE MATERIALS PROGRAM PROGRESS REPORT NO. 16, PART A. (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Oct. 15, 1962. Contract AT(40-1)-2847. 33p.

Activities in an investigation of radiation effects in BeO are reported. During this period, studies continued on preferred orientation and its effects on properties and on the expansion and strength changes in composition series specimens irradiated at both low and elevated temperatures. Irradiations of the grain size–density series specimens continued on schedule. Thermal expansion anisotropy was found to be about 12% from both x-ray measurements and correlation of thermal expansion with preferred orientation. A summary of the data on thermal expansion of both random and preferentially oriented BeO is presented. Preliminary results on grain size of irradiated specimens did not indicate significant effects of grain size or density for irradiation at 1000°C and 3.6×10^{20} nvt (≥1 Mev). Compressive creep measurements on specimens irradiated at 100°C indicated that stress does not significantly alter the thermal annealing behavior. In other studies, comparison of results of this program with those of Australian investigators provided some indication of the flux dependence of damage in BeO. (J.R.D.)

589 (HW-69169) THE REACTIVITY OF HIGH-EXPOSURE PLUTONIUM. M. D. Freshley and L. C. Schmid (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 6, 1961. Contract [AT(45-1)-1350]. 40p.

An experiment was developed to investigate the Phoenix Fuel concept for using plutonium as enrichment in fuel elements. The reactivity worth of plutonium samples which contain various initial concentrations of Pu^{240} is measured as a function of irradiation. Three samples containing plutonium of various isotopic compositions are irradiated for as many as 5 cycles each, and compared with unirradiated samples. The samples, capsule holders, flux monitor wires, irradiation procedures, measurements, and hazards are described. (M.C.G.)

590 ON THE CONDUCTIVITY OF CADMIUM SULFIDE FOLLOWING ELECTRON BOMBARDMENT. R. G. Schulze and B. A. Kulp (Aeronautical Research Lab., Wright-Patterson AFB, Ohio). J. Appl. Phys., 33: 2173-5 (July 1962).

Fine rod and whisker-type crystals of undoped CdS whose dark conductivity was of the order of 10^{-10} $(\Omega\text{-cm})^{-1}$ were bombarded with 100-kev electrons. Following bombardment, dark conductivity of the order of 10^{-9} $(\Omega\text{-cm})^{-1}$ was observed. Heat treatment to about 200°C reduced the conductivity to near its original value. Because of the high efficiency with which the electron beam raised the conductivity of the crystals, an explanation based on the redistribution of electrons and holes over existing levels rather than the production or removal of defects is required. (auth)

591 ENGINEERING SIGNIFICANCE OF IRRADIATION EFFECTS IN STRUCTURAL METALS. W. L. Fleischmann (General Electric Co., Schenectady, N. Y.). Kerntechnik, 4: 327-33(Aug. 1962). (In German)

The engineering significance of irradiation effects in structural materials is best discussed by the use of the true stress-strain diagram. The effects of irradiation are shown for stainless steel, carbon steel, copper, and nickel. When the irradiation effects are evaluated, the designer and metallurgist can take the necessary action to assure reliability of reactor components. (auth)

592 F- and M-BAND ABSORPTION IN HEAVILY GAMMA-IRRADIATED KCl. W. A. Sibley and E. Sonder (Oak Ridge National Lab., Tenn.). Phys. Rev., 128: 540-6 (Oct. 15, 1962).

Measurements of F- and M-band absorption at room temperature as a function of gamma irradiation are used to study the relation between F centers and M centers in a number of KCl crystals from a variety of sources. Although the F-center coloring curves exhibit a variety of forms, presumably due to different trace impurities and imperfections in the crystals, the M-center density seems

in all cases to be nearly proportional to the square of the F-center concentration. The ratio of the M-center concentration to the square of the F-center concentration appears to be related to trace impurity content. Zone refining decreases the relative M-center introduction, as does deliberate doping with calcium; whereas, plastic deformation has no effect on the ratio. Bleaching increases the M-center concentration at the expense of F centers; however, short re-irradiation with gamma rays causes the ratio of M-center concentration to the square of F-center concentration to return to its prebleaching value. The results are thought to indicate that a radiation equilibrium exists between F and M centers which is frozen in when the crystals are removed from the source. (auth)

593 ACTIVATION ENERGY FOR ANNEALING SINGLE INTERSTITIALS IN NEUTRON-IRRADIATED GRAPHITE AND THE ABSOLUTE RATE OF FORMATION OF DISPLACED ATOMS. Donald G. Schweitzer (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 128: 556-9(Oct. 15, 1962).

The activation energy for the process of annealing single interstitials in neutron-irradiated graphite and the absolute rate of formation of displaced atoms have been determined experimentally from both the dimensional expansions and c-axis expansions of graphite irradiated at temperatures between 77°K and 490°K. The activation energy obtained is 0.068 to 0.074 ev and lies between the value of 0.1 ev estimated by Dienes and the value of 0.016 ev calculated by Iwata, Fujita, and Suzuki for the migration energy of a single interstitial. The absolute rate of formation of displaced atoms corresponds to the rate of displacement when no annealing occurs during the irradiation process. The value obtained (5×10^{-3}% displaced atoms/Mwd), is 2.5 times the rate of displacement at 30°C and is in excellent agreement with theoretical estimates. The dimensional changes occurring during the first irradiation of graphite are the result of the three processes: (1) ϕ (fast neutron) + $C^0 \rightarrow C_1$ + vacancy, (2) $C_1 + C_1 \rightarrow C_2$, and (3) C_1 + trap $\rightarrow C_1T$. Reaction (1) corresponds to the displacement of a single interstitial by collision of a fast (high-energy) neutron and the graphite lattice. This reaction is temperature independent. Reaction (2) represents the collision of two interstitials to form a stable C_2 complex. The dimensional changes (rate of growth) occurring in graphite are due to the constant (zero-order) rate of formation of C_2. Some of the single interstitials anneal (without causing dimensional changes) by being trapped at pores, edge atoms, etc. Reaction (3) describes this process. The rate-determining step for both reaction (2) and reaction (3) is the rate of migration of the single interstitial. (auth)

594 LOW-TEMPERATURE ANNEALING SPECTRUM OF ELECTRON-IRRADIATED GOLD AND CADMIUM. Walter Bauer (Univ. of Illinois, Urbana), John W. DeFord, James S. Koehler, and John W. Kauffman. Phys. Rev., 128: 1497-1505(Nov. 15, 1962).

Cadmium and gold of 99.999% purity were irradiated to an integrated flux of 7.5×10^{17} electrons/cm^2 using 3-Mev electrons. The resistivity increase was 8.5×10^{-9} Ω-cm in gold and 2.32×10^{-9} Ω-cm in cadmium. The resistivity versus integrated flux curve is linear. Isothermal annealing measurements were made in the region from 8 to 51°K. The resistivity annealing spectrum of gold was derived directly from the isothermal annealing curves. The spectrum consists of at least nine peaks, with 22% of the damage annealing out up to 51°K. These results confirm earlier suggestions that the radiation damage in gold is basically different from that of copper and silver. It is thought that the interstitial in gold differs from that in copper and silver. In connection with the amount of low-temperature annealing, it is thought that focusing and interstitial clustering are important. Deviations from Matthiessen's rule for gold and cadmium are in qualitative agreement with theory. Only qualitative agreement with an earlier experiment on the annealing of cadmium can be confirmed. (auth)

595 MEASUREMENT OF THE STORED ENERGY IN X-RAYED SODIUM CHLORIDE. Fred T. Phelps, Jr. and Edgar Pearlstein (Univ. of Nebraska, Lincoln). Phys. Rev., 128: 1575-85(Nov. 15, 1962).

The stored energy in sodium chloride crystals irradiated with x rays at room temperature was measured by dissolving the crystals in water and measuring the temperature changes. In the range of F-center densities between 2.5×10^{17} and 6.5×10^{17} per cm^3, the curve of stored energy versus F-center density was a straight line, whose extrapolation did not intersect the origin. Quantitative interpretation of the slope of this line is difficult because of lack of knowledge about the chemical nature of a solution of irradiated NaCl. According to the interpretation favored in this article, the stored energy associated with one F center in this coloration range is 9.2 ± 0.3 ev. This value for the stored energy is in good agreement with a simple energy level scheme involving the F center, so that if there are any defects produced by x rays at room temperature which have not yet been discovered, they probably do not involve much stored energy. Crystals which have been irradiated and then thermally bleached no longer have any stored energy, from which we conclude that chlorine does not leave the crystals during irradiation or subsequent heating. (auth)

596 ELECTRON SPIN RESONANCE IN NEUTRON-IRRADIATED SILICON. M. Nisenoff and H. Y. Fan (Purdue Univ., West Lafayette, Ind.). Phys. Rev., 128: 1605-14 (Nov. 15, 1962).

Electron spin resonance produced in silicon by fast neutron irradiation was studied. The temperature of the samples during the irradiation was about 50°C. Different spectra were observed depending on the Fermi level in the irradiated sample. Samples with the Fermi level near the middle of the energy gap were studied in some detail. The observed complex spectrum was independent of the content of chemical impurities including oxygen. The spectrum simplified after annealing at temperatures ≥170°C. A center designated Si-N was identified in the spectrum of the annealed samples. The character of the g tensor and the hyperfine interaction suggest that at T ≤ 77°K the unpaired electron is in a broken bond orbital on a single silicon atom. Variation of the spectrum with temperature was studied. The results may be explained by assuming that the unpaired electron has the choice of more than one broken bond orbital in the defect center. (auth)

597 ACTION OF DEUTERON IRRADIATION UPON THE ELECTRIC RESISTANCE OF ALLOYS UNDERGOING ORDERING AND AGING. M. A. Artsishevskii, S. S. Vasil'yev, G. V. Koshelyayev, and Ya. P. Selisskii. Sb. Tr. Tsentr. Nauchn.-Issled. Inst. Chernoi Met., No. 22, 168-76 (1959).

The effect of deuteron irradiation on the electric resistance of alloys Ni_3Fe, Fe_3Al undergoing ordering and of an alloy of Fe with 35% Ni and 4.5% Ti undergoing aging was investigated. The specimens were irradiated in a cyclotron with deuterons having an energy of 4 Mev. The electric resistance measurement was carried out by the potentiometric method. Because of the small dimensions of the speci-

mens the voltage and the current leads constituted a single whole with the working part. The specimens of Ni_3Fe and of Fe_3Al were investigated in the ordered and the unordered states; the specimens of Fe-Ni-Ti were studied in the aged and hardened states. It was established that when the ordered Fe_3Al alloy is irradiated its electric resistance was increased considerably. The electric resistance of the hardened alloy dropped. Bombarding of the Ni_3Fe alloy caused a considerable decrease in the electric resistance in both states. In all cases of irradiation with fluxes up to 5×10^{17} deuterons per 1 cm^2 causes a sharp change in electric resistance at a further increase of the total flux the rate of change dropped. The effects uncovered in the Fe-Ni-Ti alloy did not exceed the limits of experimental errors. It was concluded that the most probable process causing the reduction in electric resistance is the ordering. A considerable drop in the electric resistance of the alloy Ni_3Fe was noted, whose degree of ordering corresponded to a temperature of 250 to 300°C. In this alloy a further occurrence of ordering under irradiation was possible. The shape of the electric resistance curves of the irradiated specimens tempered at 250°C confirmed the hypothesis of the attainment of an intermediate degree of ordering as result of the irradiation. In tempering the Ni_3Fe the soaking time of the specimens at the respective temperatures was insufficient to obtain an equilibrium. (Ref. Zh. Met., No. 3, 1962)

598 THE EFFECT OF ANNEALING ON THE SPATIAL DISTRIBUTION OF RADIATION DEFECTS IN SILICON. B. Ya. Yurkov (Lebedev Inst. of Physics, Moscow). Soviet Phys.-Solid State (English Transl.), 4: 626-8(Oct. 1962).

The range-energy relation for atoms that are forced to occupy interstitial sites in the crystal structure as a result of irradiation of the crystal is established. (auth)

599 CRITICAL SHEARING STRESS OF NEUTRON IRRADIATED COPPER AND GOLD SINGLE CRYSTALS. Joerg Fischer (Universität, Munich). Z. Naturforsch., 17a: 603-14(July 1962). (In German)

By a more accurate consideration of slip processes, it is possible to specify a method for the measurement of the critical shearing of irradiated crystals in expansion studies. This method permits an improved accuracy. The temperature and velocity dependence of the critical shearing stress excludes an interpretation of the irradiation by the formula proposed by Holmes. Tempering studies suggest a spectrum of activation energies by which the variation in the temperature dependence of the critical shearing stress could be explained qualitatively by the Seeger equation. The velocity dependence was confirmed with the Seeger expression. From the temperature dependence of tempered Cu samples and from the velocity dependence of the critical shearing stress and the activation energy of $U_0 \approx 1.4$ ev at 10^{18} nvt, a zone magnitude of approximately 50 Å was obtained. From the velocity dependence it follows that Au, irradiated with 7.6×10^{17} nvt, has an activation energy $U_0 \approx 1.8$ up to 1.9 ev. The dose dependence shows no new results. (tr-auth)

PHYSICS

General and Miscellaneous

Refer also to abstracts 18, 19, and 403.

600 (ACSIL/ADM/47/979) A SLIDE RULE FOR RADIATION CALCULATIONS. (Gt. Brit. Admiralty Research Lab., Teddington, Middx., England). Sept. 1947. 26p. (ARL/RI/E540)

A slide rule was developed to facilitate rapid calculations based on the Planck radiation formula. Quantities such as the radiant flux density in a given wavelength region or the spectral photon flux density at a given wavelength can be obtained readily for a black body over a range $\lambda T = 2 \times 10^2$ to 4×10^6 micron degrees with an accuracy of about 1%. Simple extension rules can be used for larger values of λT. (auth)

601 (AFCRL-62-455) RESEARCH DIRECTED TOWARD THE ATTAINMENT AND UTILIZATION OF HIGH TEMPERATURES. Final Report. J. L. Bohn, F. H. Nadig, T. Korneff, K. Moses, S. Portner, H. Edelson, R. Morton, and O. P. Fuchs (Temple Univ., Philadelphia). May 31, 1962. Contract AF 19(604)-3076. 82p.

A study of the expansion velocity in exploding wires was partially completed. Measurements of instantaneous voltage across exploding wires were obtained to an extent which demonstrated the feasibility of the method. In other work, correction of distortion processes in rotating mirror cameras is reported. Data on exploding wires at atmospheric pressure are included along with descriptions of work on mechanisms in the phenomena. Developments in three-color pyrometry are discussed. (J.R.D.)

602 (CU(PNPL)-218) PROGRESS REPORT FOR JANUARY–MARCH 1962 TO THE UNITED STATES ATOMIC ENERGY COMMISSION [ON NUCLEAR PHYSICS]. (Columbia Univ., New York. Pegram Nuclear Physics Labs.). Contract AT-30-1-GEN-72. 78p.

Details of experiments in neutron physics are given along with results of charged particle investigations. Other work is reported on light particles, theoretical investigations of formulas for beta-gamma angular correlations, and on instrument development. (J.R.D.)

603 (LADC-5480) PARTICLE-IN-CELL FLUID DYNAMICS ON THE IBM STRETCH MACHINE. Thomas Daniel Butler (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract [W-7405-eng-36]. 20p.

The particle-in-cell method of calculating fluid dynamics is discussed with particular emphasis on the application of the IBM 7030 (Stretch) computer to the method. A discussion of the uses and limitations of the numerical method as applied to certain types of problems is included in the presentation. The program which applies the particle-in-cell method on Stretch is described briefly. A typical problem, the interaction of a shock wave with a rigid cylinder, is presented, and the results are compared with experiment. In this application, the method uses a new technique for the treatment of solid barriers with which the fluid can interact. (auth)

604 (LAMS-2745) DIFFERENCE EQUATIONS FOR PLANE THERMAL ELASTICITY. George N. White, Jr. (Los Alamos Scientific Lab., N. Mex.). Aug. 1962. Contract W-7405-eng-36. 67p.

Difference equations for the displacement components of a heated, inhomogeneous, orthotropic material are obtained from a variational principle. Including boundary terms, the matrix of the resulting linear system of equations is positive semi-definite, a property which assures solution by many iterative techniques. The equations are solved for an infinite hollow cylinder of isotropic material in which the temperature varies inversely with the radius, whose inner surface is stress free, and whose outer surface is fixed. (auth)

605 (TID-15749) TABLES OF EIGENVALUES AND OF EIGENVECTORS OF HAMILTONIAN DESCRIBING THE COMBINED STATIC MAGNETIC DIPOLE AND ELECTRIC QUADRUPOLE INTERACTION OF A NUCLEAR LEVEL. R. M. Steffen (Purdue Univ., Lafayette, Ind.); E. Matthias and W. Schneider (Uppsala Univ.). Apr. 1962. Contract AT(11-1)-123. 370p.

Calculation results of the eigenvalues and eigenvectors of nuclear states of angular momentum I interacting with a magnetic field (Ho) and an axially symmetric electrostatic gradient are tabulated. The calculations were executed for the angular momentum quantum numbers I, the interaction parameters Y, and the angles β. A summary of the parameters used in the diagonalization of interaction matrices is included. (J.R.D.)

606 (TID-17018) ELECTRONIC PROCESSES IN SURFACE LAYERS OF SILVER CHLORIDE. Report No 56. Benjamin Breneman Snavely (Cornell Univ., Ithaca, N. Y. Materials Science Center). Sept. 1962. Contract AT(30-1)-2471. 137p.

Measurements of x-ray-induced photoconductivity and luminescence were correlated with the results of thermally stimulated trap emptying experiments to gain information concerning the electronic properties of the surface layer, the role of O_2, and the fate of free holes in large crystals of AgCl at 80 to 260°K. Recombination is shown to be much less probable than trapping in this temperature range. Evidence is found for a large density of traps in the surface region with depths greater than 0.1 ev which are destroyed by the presence of O_2. These traps are responsible for the reduction of photoconductivity in vacuum-annealed crystals as compared with air-annealed crystals. The results of these experiments, designed to emphasize surface effects, are compared with the bulk photoconductivity measurements of Michel. The mobility of electrons in the surface region compared closely with that measured previously for the bulk region though the electron range is less in the surface than in the bulk. The difference is attributed to a shorter electron lifetime in the surface region as compared to the buik. Experiments with halogenated crystals, in which the probability of observable hole motion should be greater than in crystals annealed in air or vacuum, failed to produce clear cut evidence for hole motion. (auth)

607 (JPRS-15740) NEWS OF HIGHER EDUCATIONAL INSTITUTIONS, MINISTRY OF HIGHER AND SECONDARY SPECIALIZED EDUCATION USSR, RADIOPHYSICS SERIES. Translation of Izvestiya Vysshikh Uchebnykh Zavedenii, Radiofizika, 5: No. 3, 423-614(1962). 451p.

A total of 22 papers is included; separate abstracts were prepared for 6 of these. The papers for which no abstracts were prepared are concerned with lasers, self-oscillators, magnetrons, feedback control devices, radioemission by the

moon, signal detection sensitivity, spectral emission of formaldehyde, and on geomagnetism. (J.R.D.)

608 (JPRS-15740(p.92-102)) DIFFUSION OF COSMIC RAYS IN INTERSTELLAR MAGNETIC FIELD. G. G. Getmantsev. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 5: 459-63(1962).

The motion of cosmic particles along randomly bent force lines of interstellar magnetic fields is considered. Three-dimensional and one-dimensional diffusion concepts are taken into account; the simultaneous presence of these leads to an appreciable decrease in the velocity of cosmic particle transport in interstellar space. An expression is derived for the mean square of the particle displacement. Expressions are also obtained for the probability distribution of particle displacement in limited cases. (J.R.D.)

609 (JPRS-15740(p.103-11)) POSSIBILITY OF MEASURING THE ELECTRON CONCENTRATION IN THE UPPER IONOSPHERE AND INTERPLANETARY SPACE BY MEANS OF PLASMA WAVE RADIATION. N. A. Mityakov and V. O. Rapoport. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 5: 464-8(1962).

A discussion of the possibility of measuring the ionospheric and interplanetary electron concentrations by the use of plasma wave radiation is presented. An expression for the radiation resistance of elementary dipoles is derived for the case of weak anisotrophy. Plots which show the frequency dependence of the radiation resistance are included. (J.R.D.)

610 (JPRS-15740(p.124-34)) CONSERVATION OF ENERGY IN THE ELECTRODYNAMICS OF MEDIA WITH SPATIAL DISPERSION. V. L. Ginzburg. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 5: 473-7(1962).

The Poynting equation was averaged at high-frequency for media having the property of spatial dispersion. The physical meaning of the various terms contained in the resulting equation is discussed. (J.R.D.)

611 (JPRS-15740(p.135-47)) TRANSITION RADIATION ON A PLASMA BOUNDARY WITH ACCOUNT OF SPATIAL DISPERSION. V. Ya. Eydman. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 5: 478-83 (1962).

The kinetic-equation method is used to analyze the transition radiation produced on a boundary of isotropic plasma. Expressions for the transition radiation energy and Cherenkov radiation in the longitudional waves emerging from a plasma to vacuum are given. (J.R.D.)

612 (JPRS-15740(p.148-63)) TRANSITION RADIATION IN OBLIQUE INCIDENCE. V. E. (Ye.) Pafomov. Translated from Izv. Vysshikh Uchebn, Zavedenii, Radiofiz., 5: 484-9(1962).

The transition radiation which occurs when charged particles pass through the boundary between two media having different dielectric constants is examined. (J.R.D.)

613 (JPRS-15740(p.203-19)) EFFECT OF CRYSTAL-LATTICE DEFECTS ON THE INTENSITY AND FORM OF NUCLEAR QUADRUPOLE RESONANCE LINES IN CRYSTALS. V. S. Grechishkin and G. B. Soyfer. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 5: 508-15(1962).

A study was made concerning the effects of x and gamma radiation from Co^{60} on the intensity and width of nuclear quadruple resonance lines in crystals. Results indicate that crystal defects can be quantitatively measured using nuclear quadrupole resonance line data, however accuracy improvement is required. (J.R.D.)

614 ASYMPTOTIC FIELD OPERATORS IN QUANTUM FIELD THEORY. Silvan S. Schweber (Massachusetts Inst. of Tech., Cambridge). Ann. Phys. (N. Y.), 19: 351-82(Sept. 1962). (NYO-10228)

The asymptotic condition in quantum field theory is formulated in terms of a limiting process involving retarded vacuum expectation values. The asymptotic fields are found for self-coupled and many-particle fields. Asymptotic fields are found that create and annihilate multiparticle bound states. The results are extended to relativistic field theory. The asymptotic fields of electrons are discussed as an example. The notion of asymptotic field is generalized to include situations in which bound states occur. (T.F.H.)

615 ON THE THEORY OF RELAXATION PROCESSES IN LIQUID HELIUM. W. E. Parry and D. ter Haar (Clarendon Lab., Oxford). Ann. Phys. (N. Y.), 19: 496-539 (Sept. 1962).

A generalized theory of the hard-sphere Bose gas is used, in conjunction with the phenomenological value of the matrix element corresponding to the scattering of two zero-momentum-state He particles, to analyze the properties of liquid He. It is shown that about half the particles should be in excited states. The excitation spectrum calculated, taking into account the presence of attractive forces, gives a poorer fit to the data than that calculated ignoring these forces. The properties of, and processes involving, rotons are discussed and used in a comparison of the hard-sphere model with experimental neutron-scattering and viscosity data on liquid He. The properties of He II containing He^3 as an impurity are studied. (T.F.H.)

616 ON THE DIRECT CONVERSION OF HEAT TO ELECTRICAL ENERGY WITH THE THERMO-ELECTRONIC DIODE. H. Huber and J. Bensimon (Compagnie Generale de Telegraphie Sans Fil, France). Ann. Radioelec., 16: 155-202(Apr. 1961). (In French)

Apart from a few very special cases, two main classes of thermo-electronic converters are recognized, namely the vacuum diode and the cesium-filled diode. The behavior of the first type of converter can be described quite rigorously, but the investigation of the second type raises difficulties regarding the behavior of the cesium plasma. The distribution of the inter-electrode potential is discussed, and a sketch is given of the main aspects of the thermo-electronic conversion of heat into electricity. Conversion efficiency is treated. The experimental results for these two categories are summarized. (auth)

617 ISOTOPE EFFECT IN AN ELECTRIC FIELD AND JUMP FREQUENCIES FOR DIFFUSION IN IONIC CRYSTALS. John R. Manning (National Bureau of Standards, Washington, D. C.). J. Appl. Phys., 33: 2145-51 (July 1962).

The simultaneous diffusion of two isotopes of a given ionic impurity in an electric field is considered, and a method of analyzing the experimental data to obtain $\Delta D/D$ is discussed. (D is the diffusion coefficient of one of the isotopes, and ΔD the difference between those of the two isotopes.) An electric field increases the accuracy with which $\Delta D/D$ can be determined. Equations are found giving this increase in accuracy as a function of field and diffusion time. If the ratio $w_{2\alpha}/w_{2\beta}$ of the jump frequencies of the two isotopes is known, relative values of the vacancy or interstitially jump frequencies near an impurity can be calculated from $\Delta D/D$ and μ/D, where μ is the drift mobility. As an example, Na^{22} and Na^{24} diffusing in KCl are considered. For self-diffusion, $w_{2\alpha}/w_{2\beta}$ may be calculated from $\Delta D/D$ and known values of the correlation factor.

When $w_{2\alpha}/w_{2\beta}$ is thus estimated for Na^{22} and Na^{24} diffusing in NaCl, a value smaller than that predicted by classical rate theory is found. (auth)

618 A SIMPLE APPROXIMATION FOR CLASSICAL SCATTERING AT LARGE ANGLES. G. Leibfreid and O. S. Oen (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 33: 2257-62(July 1962).

The classical scattering for repulsive potentials is treated approximately by a matching method. The matching potential is a cut-off potential, which matches the value and the slope of the actual potential at the distance of closest approach. The method is considered applicable to interatomic potentials of the screened Coulomb type. Comparison is made with machine results for an exponentially screened Coulomb potential. The differential cross section and the stopping power are compared for various energies. Agreement is found in the differential cross section, except for very low energy transfers. The stopping powers agree over a wide energy range with an error of only a few percent. Further comparison is made with another approximation. (auth)

619 CHARACTERISTICS AND A NEW APPLICATION OF HIGH-FIELD SUPERCONDUCTORS. Paul S. Swartz and Carl H. Rosner (General Electric Co., Schenectady, N. Y.). J. Appl. Phys., 33: 2292-2300(July 1962).

A physical and mathematical model are presented, along with experimental support of the manner in which magnetic flux penetrates into a high-field superconductor. A device using high-field superconductors in their bulk form, called a superconducting magnetic flux compressor, is proposed on the basis of this model. Theory suggests that magnetic field strengths approaching the critical field strength of a high-field superconductor (>100 kOe) should be attainable using the apparatus and techniques described. It is found experimentally with the particular high-field superconductors tested that compressed field strengths of 15 kOe can be achieved. Beyond this value anomalous magnetic flux jumping occurs, limiting the field strengths obtainable. The characteristic conditions under which magnetic flux jumping is found are discussed. The experimental results also suggest that heat is generated when a high-field superconductor is exposed to an alternating magnetic field well below the critical field strength. (auth)

620 ATTENUATION OF FAST ELECTRONS IN CRYSTALS AND ANOMALOUS TRANSMISSION. R. D. Heidenreich (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 33: 2321-33(July 1962).

The two-beam dynamical theory of electron diffraction with attenuation is treated, using imaginary potentials and a damping vector α in the Schrödinger equation. Explicit formulas are obtained for centrosymmetric crystals when the Bragg condition is realized relating the damping vectors for the two wave fields with the mean imaginary inner potential and the imaginary Fourier coefficient. Using a simplified model, the imaginary Fourier coefficients are expressed in terms of the imaginary potential P_f for nearly free electrons (plasma) and P_c for bound atom cores. It is shown that the imaginary potentials can be directly related to the total inelastic collision cross sections. Absolute numerical values are thus calculated. The values computed in this way are near the experimental results. For 10^5-v electrons, the damping vectors α are around 10^{-3} $Å^{-1}$, and the imaginary potential $P_f \cong 0.6$ v. The question of anomalous transmission is considered on the basis of the results obtained. It is concluded that the effect cannot be large for metals, but should increase with atomic number and become significant for $Z > 30$. Uncertainties in both plasma and core electron cross sections make such predictions unreliable except for a few elements. A calculation of the contribution of those electrons having energy $E_1 < E$ indicates that the E_1 electrons also can produce an "anomalous transmission." A velocity filter is thus necessary to distinguish this E_1 effect from a true anomalous transmission. (auth)

621 SOME EXPERIMENTAL CONSEQUENCES OF FLUX CONSERVATION WITHIN MULTIPLY-CONNECTED SUPERCONDUCTORS. Alvin F. Hildebrandt, Daniel D. Elleman, Frank C. Whitmore, and Randall Simpkins (California Inst. of Tech., Pasadena). J. Appl. Phys., 33: 2375-7(July 1962).

A removable ferromagnetic core is used to increase the trapped flux in a multiply-connected superconductor. This original trapped flux is then compressed by a superconducting piston so as to produce an intense magnetic field within a relatively large volume. Experiments are also described in which superconducting switches are used to compress the flux in a cyclic manner. (auth)

622 INITIATING AND MAINTAINING A DISCHARGE BY A TRANSFER MECHANISM. Lorin K. Hansen and K. R. Mackenzie (Univ. of California, Los Angeles). J. Appl. Phys., 33: 2383-4(July 1962).

A discharge is described that is radially contained by a magnetic field and is not sustained by electron emission from any surface. Two positive anodes of arbitrary but similar shape are lined up along the magnetic field. A control electrode, at a lower potential, is placed between them and creates a potential barrier and two positive potential wells in the vicinity of each anode. Electrons are axially trapped in these wells. A r-f voltage in the megacycle range is applied, out of phase, to the two anodes and causes the trapped electrons to alternately spill across the barrier and pick up energy from the r-f field. During each half-cycle, the electrons make many oscillations in the potential well that is most positive, and make ionizing collisions. Every ion pair yields an electron, which can gain energy in the same way. The process is very efficient and is characterized by r-f breakdown voltages that approach the ionization potential of the gas. (auth)

623 SUDDEN ENHANCEMENT OF ATMOSPHERICS ASSOCIATED WITH HIGH ALTITUDE NUCLEAR EXPLOSIONS. M. K. Das Gupta and A. K. Sen (Univ. of Calcutta). J. Atmospheric and Terrest. Phys., 24: 739-40(Aug. 1962).

Sudden enhancement of atmospheric (s. e. a.) events associated with high-altitude Russian nuclear explosions between Sept. 1 and Nov. 4, 1961, are studied at a frequency of 120 kc. S. e. a. events occur following 11 of 16 explosions having yields over 1 Mt, and following 1 of 14 explosions having yields under 1 Mt. The delays between the explosions and the s. e. a. events, and the durations of the s. e. a. events, are discussed. (T.F.H.)

624 TOTAL SCATTERING CROSS SECTIONS OF H_2O AND NH_3. Paul H. Kydd (General Electric Research Lab., Schenectady, N. Y.). J. Chem. Phys., 37: 931-3 (Sept. 1, 1962).

Molecular beam scattering experiments were performed to determine the total scattering cross sections, Q, and the van der Waals constants, C, of H_2O and NH_3 beams in an effusive flow of H_2O. $C_{H_2O-H_2O}$ was found to be $610 \pm 150 \times 10^{-60}$ erg-cm^6 which is larger than the calculated value 313×10^{-60}, as would be the case if short-range dipole–dipole forces, not included in the calculation, were effective. $C_{NH_3-H_2O}$ is smaller than calculated, $176 \pm 50 \times 10^{-60}$ compared to 292×10^{-60}, as though the dipole–dipole

forces were altogether inactive. An attempt was also made to measure the temperature dependence of $Q_{H_2O-H_2O}$. (auth)

625 EXCHANGE OF INTERACTING NUCLEAR SPINS IN NUCLEAR MAGNETIC RESONANCE. I. INTRAMOLECULAR EXCHANGE. S. Alexander (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 37: 967-74(Sept. 1, 1962).

The effect of internal-exchange processes in a molecule on high-resolution nuclear magnetic resonance spectra is investigated. A Boltzmann equation governing the behavior of the nuclear spin density matrix is derived. This equation is valid for arbitrary coupling strengths and exchange rates. The methods of solving this equation are discussed and, in particular, it is shown that the calculation of the steady-state (slow-passage) NMR spectrum can be reduced to the solution of a set of simultaneous linear algebraic equations. Explicit approximation formulas for the slow- and fast-exchange limits are derived and a number of examples discussed in detail. (auth)

626 EXCHANGE OF INTERACTING NUCLEAR SPINS IN NUCLEAR MAGNETIC RESONANCE. II. CHEMICAL EXCHANGE. S. Alexander (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 37: 974-80 (Sept. 1, 1962).

The study of the effect of exchange on high-resolution nuclear magnetic resonance spectra is extended to chemical exchange. A Boltzmann equation for the nuclear spin density matrix is derived. This equation is nonlinear because two uncorrelated molecules participate in each exchange process. For temperatures high compared to the nuclear Zeeman energy, the equations can, however, be linearized. In particular, the steady-state (slow-passage) solutions can be obtained from a set of linear algebraic equations for the elements of the density matrix. Explicit approximation formulas for the slow- and fast-exchange limits are derived. As an example, the spectrum of a molecule with two nonequivalent spin $\frac{1}{2}$ nuclei, one of which is exchanging, is calculated explicitly for arbitrary exchange rates and coupling strengths, and the behavior of the spectrum is discussed in detail. (auth)

627 FACTORS CONTROLLING THE INTENSITY OF EMISSION OF Eu^{3+} AND Tb^{3+} IN SCHEELITES. L. G. Van Uitert (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 37: 981-5(Sept. 1, 1962).

Measurements were carried out under broadband long-wave ultraviolet excitation to determine the dependences of the intensity of emission of Eu^{3+} or Tb^{3+} upon the host-structure cation valence, radius, and ionization potential in compositions which have the scheelite structure. Brightness can either increase or decrease with the binding energy of the rare-earth ion depending upon the strength of coupling between the ion and its environment. In the case of Tb^{3+}, the former occurs in the tungstates and the latter in the molybdates. (auth)

628 QUENCHING INTERACTIONS BETWEEN RARE-EARTH IONS. L. G. Van Uitert and S. Iida (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 37: 986-92(Sept. 1, 1962).

Interactions between identical or nonidentical rare-earth ions that result in the quenching of fluorescence of Eu^{3+} or Tb^{3+} were studied. Comparison of the intensities of emission of Eu^{3+} as a function of its concentration in various oxides indicates that interactions that result in the quenching of emission from the $^5D_0$ levels of the Eu^{3+} ions are associated with pairing through intervening oxygen ions. Higher-lying levels appear to be quenched by interactions through anionic groups (e.g., WO_4^{2-}). The quenching effects that a dissimilar rare-earth ion M have on the emission of Eu^{3+} or Tb^{3+} in the sodium rare-earth tungstates correlate with (1) the energy gap between the fluorescing level of the latter and the closest lower-lying level of M, and (2) the total orbital angular momentum of the ground state of M. (auth)

629 ADSORPTION OF POTASSIUM BEAMS ON SURFACES. Forrest S. Baker and Gilbert O. Brink (Univ. of California, Livermore). J. Chem. Phys., 37: 1012-17 (Sept. 1, 1962). (UCRL-6796)

The adsorption probabilities were measured for a thermal potassium beam impacting on 20 different target materials. These measurements, when included in the general body of previously published data, permitted the derivation of several empirical relations involving binding energies, adsorption coefficients, and heats of formation. These relations may find application in predicting other coefficients and binding energies. Thus the tedium of time-consuming experiments usually required in the search for suitable beam-collector materials may be significantly reduced. (auth)

630 MAGNETIC SUSCEPTIBILITY OF RUTHENIUM–YTTRIUM OXIDE ($Ru_2O_4 \cdot Y_2O_3$) POWDER. J. Rosset and D. K. Ray (Institut Fourier, Grenoble, France). J. Chem. Phys., 37: 1017-20(Sept. 1, 1962).

Detailed analysis of the magnetic susceptibility of $Ru_2O_4 \cdot Y_2O_3$ powder shows that the Ru^{4+} ion experiences an appreciable trigonal field and some covalent bonding. Possible explanations were given of the deviation of the experimental susceptibility data in the high-temperature region from theoretical models considered here. (auth)

631 ON THE ANALYSIS OF SPECTRA IN TRANSMISSION THROUGH THIN FILMS. D. J. Montgomery and K. F. Yeung (Michigan State Univ., East Lansing). J. Chem. Phys., 37: 1056-61(Sept. 1, 1962).

A technique to investigate the adequacy of the damped harmonic-oscillator model for infrared absorption in thin films is described, together with a simple procedure for extracting the material parameters and the film thickness from the transmission curve. The methods are illustrated by application to several ionic crystals. (auth)

632 TOTAL COLLISION CROSS SECTIONS FOR SCATTERING OF THERMAL BEAMS OF HYDROGEN, HYDROGEN ATOMS, AND HELIUM BY HYDROGEN AND HELIUM. Halstead Harrison (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Chem. Phys., 37: 1164-5(Sept. 1, 1962).

Measurements were made on the velocity dependence of total scattering cross sections for interactions of hydrogen atoms, helium, and hydrogen molecules with hydrogen and helium. The results show almost no velocity dependence; the greatest slope is less than half that predicted by the Massey-Mohr equation. (D.L.C.)

633 INTERMEDIATE STATISTICS. A. M. Guénault and D. K. C. MacDonald (National Research Council, Ottawa). Mol. Phys., 5: 525-30(Sept. 1962).

The properties of a gas of particles obeying a hypothetical "intermediate statistics" are discussed. Although the analysis has no known direct application to a physical system, the theoretical results can help in understanding the physical properties of Fermi-Dirac and Bose-Einstein statistics. (auth)

634 THE MAGNETOHYDRODYNAMIC GENERATORS. PART II. Wojciech Brzozowski (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 7: 287-309(1962). (In Polish)

A study is made of thermodynamic and gasdynamic phenomena occurring in so-called magnetohydrodynamic generators. The derived formulas are based upon simplifying assumptions relating to the working medium. Changes of state are presented in heat diagrams (T-s) and work diagrams (P-ν). (auth)

635 TEMPERATURE-EFFECT OF KNIGHT SHIFTS IN ALKALI METALS. T. Muto, S. Kobayasi, M. Watanabe, and H. Kozima (Tokyo Univ.). Phys. and Chem. Solids, 23: 1303-27(Sept. 1962).

The effect of lattice vibrations upon Knight shift was worked out theoretically, which is caused by two kinds of mechanisms; the effect of lattice vibrations upon hyperfine interaction and the influence of lattice vibrations upon charge distribution of conduction electrons. A correction term to the usual expression of Knight shift was obtained successfully, which depends explicitly upon not only temperature but also ion mass. It, therefore, is expected for both temperature-effect and isotope-effect of Knight shift to be observed experimentally. The observed changes with temperature of Knight shift of alkali metals at constant volume are found to get fair agreement with the numerical calculations. (auth)

636 THE THERMOLUMINESCENT EMISSION SPECTRA OF X-RAY IRRADIATED ALKALI HALIDES. L. A. McLachlan (Victoria Univ. of Wellington, New Zealand). Phys. and Chem. Solids, 23: 1344-6(Sept. 1962).

The emission spectra of NaCl, KCl, KBr, and NaBr powders irradiated at 80°K by x rays and heated to ~400°K, were studied at 340 to 560 mμ. The observed peaks are attributed to radiative combination of electrons in the conduction bands with trapped O_2 to form O_2^- ions. (D.L.C.)

637 TRANSONIC FLOW OF A PERFECTLY CONDUCTING GAS WITH ALIGNED MAGNETIC FIELD. Ko Tamada (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 5: 871-8(Aug. 1962).

The two-dimensional transonic flow of a perfectly conducting, inviscid, compressible fluid past a thin body with aligned magnetic field is studied by developing a small-perturbation theory in the hodograph plane. It is shown that the equations of motion, as well as the conditions for possible shock waves, can be reduced to those of ordinary flow by a suitable affine transformation. Thus the transonic similarity law is extended to the class of magneto-gas-dynamic flow. In this extension, super-Alfvénic flows (flow speed larger than Alfvén wave speed) are found to be similar to the corresponding ordinary flow, while sub-Alfvénic flows are related to the ordinary flow with reversed flow direction. The flow over a half-wedge at Mach number 1 is considered. (auth)

638 VELOCITY AND TEMPERATURE PROFILES FOR LAMINAR MAGNETOHYDRODYNAMIC FLOW IN THE ENTRANCE REGION OF AN ANNULAR CHANNEL. J. L. Shohet (Johns Hopkins Univ., Baltimore). Phys. Fluids, 5: 879-84(Aug. 1962).

The entry problem for an annular channel configuration that has a particular profile for its fully developed condition is solved numerically for various values of the pertinent parameters describing the flow. The nonlinearities present in the momentum and energy equations are utilized in the solution of the problem by placing the equations in a finite difference form. For a large accelerating electric field the velocity profile is found to reverse itself in an area near the outer wall of the channel. Velocity, temperature, and pressure curves are computed. (auth)

639 CLASSICAL SCATTERING BY SOME IMPORTANT REPULSIVE POTENTIALS. E. M. Baroody (Battelle Memorial Inst., Columbus, Ohio). Phys. Fluids, 5: 925-32(Aug. 1962).

Classical scattering by repulsive potentials of the form $V = Br^{-n} \exp(-r/a)$ is analyzed in terms of two energy-dependent parameters, the distance of closest approach (c) in head-on collision, and a slope parameter $\gamma = -(d \ln V/d \ln r)_{r=c}$. Use of these parameters brings out relations among values of cross sections for various potentials, and facilitates the derivation of certain asymptotic analytic relations, e.g., when γ is large or near unity. Asymptotic expressions are calculated for the differential and transport cross sections. For the exponential potential, the asymptotic analytic behavior of collision integrals for large values of $\alpha = \ln(B/kT)$ is determined and compared with numerical results. For the exponentially screened Coulomb potential, a simple expression describing the dependence on γ is selected and used in treating the energy loss of a fast heavy atom being stopped by elastic collisions in a gas of light atoms. This discussion makes clear the basis and scope of the Bohr-Nielsen range-energy equation. (auth)

640 ELECTROHYDRODYNAMICS OF SUPERFLUID HELIUM IN NARROW CHANNELS. W. Jim Neidhardt and Jack Fajans (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev., 128: 495-502(Oct. 15, 1962).

The flow of superfluid helium from a liquid reservoir to vacuum through a 10^{-5} cm channel, which was enhanced tenfold by an electric field of 3×10^6 v/cm when a phase boundary occurred within the channel, was unaffected when the boundary moved past the channel and field. Superfluid flow at subcritical velocity given by $\Gamma - \Gamma_0 = f(T)V^2$, when increased to critical flow under the influence of electrostrictive pressures, was given by $\Gamma = [\rho_n/\rho]\,[\eta(T_\lambda)/\eta(T)]K_n + [\rho_s/\rho]K_s$, with Γ and Γ_0 the flow with and without applied electric field, V the applied voltage, T the temperature, ρ_n and ρ_s the normal and superfluid densities, ρ the total density, η the viscosity, and K_n and K_s flows obtained from normalization of data. A coincidence was noted between a maximum at 2.08°K in the relative flow and an already reported maximum at 2.10°K in thermal boundary conduction. Any shift in the λ point induced by a macroscopic field of 1.5×10^6 v/cm was less than 0.02°K, but displacements as great as 0.5°K were induced by use of very fine channels. (auth)

641 FILM FLOW OF LIQUID HELIUM AT LOW-PRESSURE HEADS. H. Seki (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 128: 502-8(Oct. 15, 1962).

A steady-state method was developed and used to measure the flow rate of saturated liquid-helium films at small pressure heads. In this method a steady heat input into a glass vessel partially immersed in liquid helium generates the film flow inwards. A steady state is established when the rate of film flow is equal to the rate of distillation out of the vessel. The flow rate was derived from the temperature difference and level difference between the liquid in the vessel and the bath. Measurements in the vicinity of 1.2°K indicate a marked pressure-head dependence of the flow rate below a pressure head of 0.01 cm of liquid helium. A maximum flow rate for zero pressure head (±0.001 cm of liquid helium) of about 5×10^{-5} cc/sec cm is observed. This rate is suggested to be the true critical flow rate of the film. (auth)

642 HARTREE CALCULATIONS FOR THE GROUND STATE OF SOLID He AND OTHER NOBLE GAS CRYSTALS. Lewis H. Nosanow and Gordon L. Shaw (Univ. of California, San Diego, La Jolla). Phys. Rev., 128: 546-50(Oct. 15, 1962).

A single-particle model in which the wave functions are

spherically symmetric about each lattice site was used to calculate the ground-state energy E_0 of solid He. The self-consistent Hartree equations (which yielded the best such wave functions) were solved numerically to an accuracy of better than 1%. The results were worse than could have been expected a priori: At the observed densities, the calculated values of E_0 were approximately +34 and +14 cal/mole for He^3 and He^4, respectively, as compared with experimental values of −4.5 and −12 cal/mole. Previous calculations are discussed in the light of the results. In addition, E_0 for the crystals of the other noble gas elements was calculated. The results for Ar, Kr, and Xe are within experimental error whereas E_0 for Ne is definitely outside this error (being about 5% higher than experiment). (auth)

643 INVESTIGATION BY ELECTRON TUNNELING OF THE SUPERCONDUCTING ENERGY GAPS IN Nb, Ta, Sn, AND Pb. P. Townsend and J. Sutton (Plessey Co. Ltd., Towcester, Northants, Eng.). Phys. Rev., 128: 591-5 (Oct. 15, 1962).

Electron tunneling between two superconductors separated by a thin potential barrier gives rise to non-linear current vs voltage characteristics, from which a direct measurement of their energy gaps can be obtained. The temperature dependence of the I:V characteristics for sandwiches of Ta/barrier/Pb and Nb/barrier/Sn has been studied and the energy gaps of tin and tantalum determined up to their transition temperatures. Good agreement has been obtained between the temperature dependence observed experimentally, and the predictions of the Bardeen, Cooper, and Schrieffer (BCS) theory of superconductivity. The full limiting values of the superconducting energy gaps obtained are $2\epsilon_{Nb} = (3.05 \pm 0.05) \times 10^{-3}$ ev, $2\epsilon_{Ta} = (1.40 \pm 0.05) \times 10^{-3}$ ev, and $2\epsilon_{Sn} = (1.15 \pm 0.06) \times 10^{-3}$ ev. The lead apparently exhibited two prominent energy gaps with values of $2\epsilon_{Pb}^{(1)} = (2.67 \pm 0.05) \times 10^{-3}$ ev and $2\epsilon_{Pb}^{(2)} = (2.90 \pm 0.05) \times 10^{-3}$ ev, at 0°K. This behavior is tentatively ascribed to anisotropy. Theoretical characteristics have been computed, using the BCS density-of-states expression, $\rho = E/(E^2 - \epsilon^2)^{1/2}$, and compared with the experimental results. Possible reasons for the deviations observed are discussed. (auth)

644 LATTICE THERMAL CONDUCTIVITY OF SOLID HELIUM. Bal Krishna Agrawal and G. S. Verma (Univ. of Allahabad, India). Phys. Rev., 128: 603-5(Oct. 15, 1962).

Callaway's theory is applied to explain the thermal conductivity of solid He^4 at different densities i.e., $\rho = 0.194$, 0.262, and 0.282 g/cm³, where the data are available on either side of the conductivity maximum. Good agreement between theory and experiment is obtained by taking $\alpha = 2.4$ for all the three cases for the exponential temperature dependence of umklapp processes given by $\propto e^{-\theta/\alpha T}$, which verifies the θ dependence of umklapp processes. The present calculations also reveal the importance of normal processes near the conductivity maximum where the correction term in Callaway's expression for thermal conductivity dominates. This also shows that the additivity of reciprocal relaxation times is not valid for single isotope pure solid helium. The calculations also suggest the presence of internal boundaries in the composition of the solid. (auth)

645 SOME ASPECTS OF THE KAPITZA RESISTANCE. J. I. Gittleman and S. Bozowski (RCA Labs., Princeton, N. J.). Phys. Rev., 128: 646-9(Oct. 15, 1962).

The Kapitza resistance of tin and indium, in both the superconducting and normal states, and sapphire have been measured in the temperature range of 1.3 to 2°K. The results are compared with those reported for superconducting and normal lead as well as with the predicted values from current theory. Although qualitative agreement with the theory is obtained, large discrepancies in the absolute value of the Kapitza resistance as well as its temperature dependence for metals in their superconducting state are observed, suggesting the existence of other, as yet undiscovered, parallel mechanisms. The effect of electric field on the Kapitza resistance between platinum and liquid helium was investigated with the hope of determining the influence of the coupling between the phonons of the liquid and the part of the electronic wave functions of the metal which decay into the liquid on the Kapitza resistance. Under our experimental conditions, no effect is observed. (auth)

646 MEASUREMENTS OF INELASTIC ENERGY LOSS IN LARGE-ANGLE Ar^+ ON Ar COLLISIONS AT kev ENERGIES. Gerry H. Morgan and Edgar Everhart (Univ. of Connecticut, Storrs). Phys. Rev., 128: 667-76(Oct. 15, 1962).

Large-angle collisions of Ar^+ ions with Ar atoms are studied in which the inelastic energy loss Q is measured as a function of incident energy and scattering angle. Measurements are made at 3-, 6-, 12-, 25-, 50-, 75-, and 100-kev incident energies and the recoiling target particles are studied at several angles ϕ between 84° and 52°, corresponding to collisions where the scattered incident particle is scattered through angles θ between about 6° and 38°. The kinetic energies and scattering angles of the recoils are accurately measured, and this, together with the conservation equations, permits determination of the inelastic energy. The average value of the inelastic energy loss $\bar{Q}$ is plotted vs recoil angle ϕ and a separate curve is obtained for each incident energy. However, when the various $\bar{Q}$ values are plotted vs the calculated distance of closest approach, a universal curve is obtained which has an abrupt rise when this distance is 0.23 Å irrespective of energy. The $\bar{Q}$ values are a weighted average of the energy losses associated with the various charge states found among the recoil particles at a given angle, the energy loss $\bar{Q}_n$ of a particular charge state n being weighted in accordance with its abundance. The several values of $\bar{Q}_n$ are presented for each of several angles ϕ at each energy studied. In a few cases a fine structure was seen in the data. For example, in 12-kev Ar^+ on Ar collisions, the recoils at $\phi = 52°$ are found to contain Ar^{2+} ions (as well as Ar^+, Ar^{3+}, etc.). Here these Ar^{2+} ions arise from collisions where the average value is $\bar{Q}_2 = 234$ ev. However, this is a weighted average of three just resolved groups of slightly different energies and these correspond to Q's of 90, 318, and 620 ev. These are interpreted as arising from collisions where the (unobserved) scattered incident particle is Ar^+, Ar^{3+}, and Ar^{5+}, respectively. Thus, individual Q values are obtained for these reactions. There is evidence that the electrons usually leave in groups of two during these violent collisions. (auth)

647 PHOTOIONIZATION FROM OUTER ATOMIC SUBSHELLS. A MODEL STUDY. John W. Cooper (National Bureau of Standards, Washington, D. C.). Phys. Rev., 128: 681-93(Oct. 15, 1962).

Calculations of photoionization cross sections are reported which emphasize the spectral range (from threshold to ~150 ev above it) where the bulk of the optical oscillator strength is distributed and where the cross sections are large but experimental evidence is scarce. Light absorption by a single electron moving in a potential similar to the Hartree-Fock potential appropriate to the outer sub-

shell of each atom was used as a model. Data are reported for the rare gases He, Ne, Ar, and Kr, for Na, and for the closed-shell ions Cu^+ and Ag^+. Sum rules are used to analyze the oscillator strength spectral distribution and to attempt extrapolations to still higher energies. The results suggest a classification of atomic subshells into two types with fundamentally different spectral distributions of oscillator strength. One type consists of the subshells 1s, 2p, 3d, 4f, with nodeless radial wave functions, the other type includes all remaining subshells. The present calculations are regarded as a first approximation to be improved upon by taking into account configuration interaction. (auth)

648 CAUSALITY AND MULTIPLY CONNECTED SPACE-TIME. Robert W. Fuller (Columbia Univ., New York) and John A. Wheeler. Phys. Rev., 128: 919-29 (Oct. 15, 1962).

With the introduction of multiply connected topologies into physics, a question of causality arises. There are alternative routes between two points in a multiply connected space. Therefore, one may ask if a signal traveling at the speed of light along one route could be outpaced by a signal which has traveled a much shorter path through a handle or "wormhole." This paper examines one such situation and shows that in this example causality is preserved. It proves essential in the analysis to distinguish between those regions of space-time which are catastrophic and those which are not. A catastrophic region is composed of catastrophic points. A catastrophic point in space-time is so located with respect to eventual singularities in the intrinsic geometry that every time-like geodesic through it necessarily runs into a region of infinite curvature at some time in the future—or was born out of a region of infinite curvature at some time in the past—or both. If a classical analysis of nature were possible—which it is not—then it would be natural to postulate that laboratory physics is carried out in noncatastrophic regions of space-time. Two such regions are shown to exist in the example considered. It is shown that no signal can ever be sent from one to the other. The key point in preventing any violation of causality is simple: The (Schwarzschild) throat of the wormhole pinches off in a finite time and traps the signal in a region of infinite curvature. This investigation also displays some of the unusual geometric features of the Schwarzschild solution of Einstein's equations for a spherically symmetrical center of attraction. Radial spacelike geodesics passing through the throat are calculated and it is shown that there exist regions of space-time unreachable by any radial geodesics that issue from a given point. Also, there exist points in space-time from which light signals can never be received no matter how long one waits. (auth)

649 NONIDEAL BOSE GAS AT NONZERO TEMPERATURES. W. E. Parry and R. E. Turner (Clarendon Lab., Oxford). Phys. Rev., 128: 929-32(Oct. 15, 1962).

An extension to nonzero temperatures of the Hugenholtz-Pines procedure for the degenerate Bose gas is provided. It is shown that under certain conditions the elementary excitation spectrum must approach zero for zero momentum, at nonzero, as well as at zero temperatures. The apparent discrepancy of this result with the particular case of a charged boson gas with a uniform positive background is discussed. Finally, a suggestion is made for modifying the Bogoliubov approximation, which is particularly relevant at nonzero temperatures. (auth)

650 HEAT CAPACITY OF SOLID He^3. E. C. Heltemes and C. A. Swenson (Ames Lab., Ames, Iowa). Phys. Rev., 128: 1512-19(Nov. 15, 1962). (IS-488)

Exploratory specific-heat measurements have been made on solid He^3 for the temperature range from 0.3 to 2°K and to 1800 bars pressure. The data for the relatively high-pressure hcp βHe^3 phase could not be represented by a Debye function, since anomalous behavior was found at low temperatures for the smaller molar volumes. Similar effects were found for the same phase in solid He^4. The data for the low-pressure bcc αHe^3 phase could be described within experimental accuracy by the sum of a Debye function and an Einstein function representing two degrees of freedom. The characteristic temperatures which are associated with the Debye function and the Einstein function respectively were found to be functions of the molar volume, and to be linearly related. These data, together with earlier values of the thermodynamic parameters along the melting line given by other workers, were used to calculate the equation of state for αHe^3, and, hence, the thermal expansion and compressibility as a function of temperature and pressure. Several unusual features were found as a result of this analysis; these include the Einstein anomaly in the specific heat of αHe^3, the fact that the compressibility of αHe^3 is appreciably greater than that of the fluid or βHe^3 at the same molar volume, and the relatively large difference between the Debye θ's for the α and β phases (about 20%) which differ in molar volume by only 0.5%. These effects do not appear to be due to nuclear ordering. No evidence for a previously predicted negative thermal expansion in αHe^3 was found. (auth)

651 THERMAL EXCITATIONS IN SOLID He^4. Louis Goldstein (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 128: 1520-30(Nov. 15, 1962). (LADC-5306)

The present paper is devoted to an extension of recent work on solid He^4 using a heuristic approach. The anomalous or negative isobaric expansion coefficients of the solid, in equilibrium with the anomalous liquid He^4II, will be reevaluated in terms of the here derived approximate compressibilities of the solid based on sound velocity data. The entropy of solid He^4 will then be obtained in terms of the recent Los Alamos determinations of entropy changes on solidification and of two different sets of entropy values of the liquid along the melting line. The latter yield two distinct sets of solid entropy values. While numerically these are different, they appear to be much too large to be accommodated by simple phonon excitations of the solid at temperatures below $T_\theta(p_m)$, the temperature of the heat capacity anomaly of the liquid at the melting pressure line p_m. Below $T_\theta(p_m)$, both of these numerically different solid entropies exhibit temperature variations of such strength as to rule out their description in terms of simple phonon entropies. In addition, the two sets of solid entropies give rise to molar heat capacities of the order of the gas constant R, at the approaches of $T_\theta(p_m)$. The preceding thermal anomalies will be discussed from the viewpoint of the equilibrium between the fundamentally anomalous liquid and the solid. Analysis of the liquid entropy yields a new set of onset temperatures of the ordering process responsible for its peculiar transition phenomenon. The thermal anomalies, at or in the vicinity of the melting line, suggest peculiar dispersion and distribution properties of the frequency spectrum of solid He^4. Direct experimental investigations of the above apparent anomalies of the static thermal properties as well as of transport properties of this solid near the phase separation line seem to be of interest. (auth)

652 DECAY OF AN ELECTRIC CURRENT IN A SUPERCONDUCTOR. Jitendra C. Parikh (Univ. of Chicago). Phys. Rev., 128: 1530-8(Nov. 15, 1962). (EFINS-62-29)

A theory of the decay of an electric current in a superconductor is presented. The calculations have been done using a model within the BCS theory of superconductivity, ignoring magnetic effects. The decay of current, from a specially chosen initial state, is found both for low temperatures and for temperatures near the critical temperature. The persistence of currents remains unexplained. The related problem of thermal conductivity is re-examined in an appendix. (auth)

653 SUPERCONDUCTIVITY IN THE CASE OF OVERLAPPING BANDS. M. Suffczynski (Univ. of Rochester, N. Y.). Phys. Rev., 128: 1538-9(Nov. 15, 1962).

The equations for the superconductivity energy gap and transition temperature in the case of overlapping bands are derived by the Nambu-Schrieffer formalism. (auth)

654 KNIGHT SHIFTS AND MAGNETIC SUSCEPTIBILITIES IN V ALLOYS WITH Ti, Cr, AND Tc. D. O. Van Ostenburg, D. J. Lam, H. D. Trapp, and D. E. MacLeod (Argonne National Lab., Ill.). Phys. Rev., 128: 1550-4 (Nov. 15, 1962). (ANL-FGF-355)

Knight shifts, K_V, of the V^{51} isotope have been measured in binary alloys of V with Ti, Cr, and Tc. The shifts, K_{Tc}, of the Tc^{99} nucleus have been measured over the whole composition range in the V–Tc system together with corresponding magnetic susceptibilities. The results on these bcc alloys indicate that the rigid band approximation is valid and nearly all electrons outside the closed 3p or 4p shell form a common conduction band with admixtures of s and non-s electronic states. Furthermore, these data augmented by electronic specific-heat measurements indicate that the proportion of electrons having s and non-s character changes with electron concentration within this common conduction band. (auth)

655 SPECIFIC HEAT OF SINGLE-CRYSTAL $MnCl_2$ IN APPLIED MAGNETIC FIELDS. R. B. Murray (Oak Ridge National Lab., Tenn.). Phys. Rev., 128: 1570-4 (Nov. 15, 1962).

The specific heat of a single-crystal sample of $MnCl_2$ has been measured, in the liquid-helium temperature region, in applied magnetic fields extending up to 7.26 kOe. In all cases the magnetic field was applied parallel to an a axis of the hexagonal cell. The two specific heat maxima, which have been previously reported at 1.81 and 1.96°K in zero field, are associated with antiferromagnetic transitions. Both transition temperatures are found to be field dependent. The upper transition temperature increases with applied field while the lower transition temperature decreases. These results are correlated with neutron diffraction studies of the magnetic structure transitions. (auth)

656 PARAMAGNETIC RESONANCE AND CHARGE COMPENSATION OF TETRAVALENT URANIUM (U^{4+}) IN CALCIUM, STRONTIUM, AND BARIUM FLUORIDES. Amnon Yariv (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Rev., 128: 1588-92(Nov. 15, 1962).

A new electron spin paramagnetic resonance spectrum in CaF_2 doped with uranium is attributed to U^{4+}. The spectrum possesses axial symmetry about the (111) directions and is describable by a spin Hamiltonian with $g_\perp = 0 \times 0.15$ and $g_{||} = 3.238 \pm 0.005$ at 4.2°K. The trigonal symmetry is due to the presence of charge compensating O^{2-} ions along the (111) directions. The spectrum is absent in crystals grown under reducing conditions. Similar results were also observed in SrF_2 and BaF_2. (auth)

657 TRACE RELATIONS FOR TENSORS RELATING ELECTRIC FIELDS AND ELASTIC STRAINS TO NUCLEAR QUADRUPOLE EFFECTS. Ralph J. Harrison and Paul L. Sagalyn (U. S. Army Materials Research Agency, Watertown, Mass.). Phys. Rev., 128: 1630-1(Nov. 15, 1962).

The effects of electric field and elastic strain on the nuclear quadrupole interactions in crystals have been described by means of third- and fourth-rank tensors relating the change of the electric field gradient tensor components ϕ_{ij} to the components E_k of the applied electric field and to the components e_{lm} of the strain tensor. Usual symmetry relations reduce the number of independent components of the coupling tensors. In addition to the relations due to symmetry, other relations among the components of the coupling tensor have been usually obtained from the assumption that the change in the trace $\Sigma_i \phi_{ii}$ due to applied electric field or strain is equal to zero. It is shown that the number, but not the interpretation, of the independent tensor coefficients is independent of the assumption about the trace. (auth)

658 ENERGETIC STABILITY OF PERSISTENT CURRENTS IN A LONG HOLLOW CYLINDER. F. Bloch (Stanford Univ., Calif.) and H. E. Rorschach. Phys. Rev., 128: 1697-1714(Nov. 15, 1962).

An extension is given of the work of Schafroth in which the carriers of electricity in a superconductor are assumed to constitute an ideal Bose gas. The long-range electromagnetic interactions are fully taken into account by the method of the self-consistent field. The corresponding general equations are obtained from a variational principle applied to the total energy of the system, and the change of the total energy due to individual particle transitions is considered. Axially symmetric solutions are found for the geometry of a long hollow cylinder and for the case in which all particles are in the same lowest single-particle level compatible with the angular momentum $l'\hbar$ around the cylinder axis. This case represents a state of the system in which l' flux quanta are trapped in the cylinder. Assuming the lattice to be at $T = 0$, such a state will be stable against single-particle transitions if the corresponding energy change of the system is positive. This state need not be the state of lowest energy, but it would have a practically infinite lifetime if the stability criterion against single-particle transitions is satisfied. Indeed, its energy could only be lowered by a simultaneous transition of a number of particles comparable to their total number, which would be an extremely rare event. It is shown that stability depends on the fields H_1 and H_2 in the cylinder hole and outside the cylinder, respectively. For $H_1 = H_2$, stability requires that these fields be less than $H^* = 4\pi n\mu_0$, where n is the density of the bosons and μ_0 is the Bohr magneton. For $H_2 = 0$, it requires that $H_1 < (H_c)_T$ where $(H_c)_T$ depends upon the hole radius r_1 and the wall thickness d. For $d \gg r_1$, one finds $(H_c)_T = H^*$, while for $d \ll r_1$, one has $(H_c)_T = (d/r_1)H^*$. The difference between $(H_c)_T$ and H^* for $d \ll r_1$ is further investigated, and it is shown that the case for which $H^* > H_1 > (H_c)_T$ may nevertheless experimentally appear to be stable since the stability conditions are strongly modified considering that the transfer of very small but finite amounts of energy to the lattice may not occur during the time of a measurement. (auth)

659 THERMAL BROADENING OF THE MÖSSBAUER LINE AND OF NARROW-LINE ELECTRONIC SPECTRA IN SOLIDS. R. H. Silsbee (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 128: 1726-33(Nov. 15, 1962).

The dependence of the lattice vibration Hamiltonian upon the excitation state of an electron or nucleus is examined as a possible source of thermal broadening of narrow-line electronic spectra or Mössbauer spectra in solids. A

simple model is proposed to illustrate this mechanism and calculational techniques described to determine the line width appropriate to that model. Application to the Mössbauer problem shows the absence of any observable thermal broadening except in the case of localized modes. The mechanism is consistent with the observed thermal broadening of the narrow lines of ruby, but that specific problem appears to be too complex to permit a detailed test of the theory. (auth)

660 ANOMALOUS QUADRUPOLE COUPLING IN EUROPIUM ETHYLSULFATE. B. R. Judd, C. A. Lovejoy, and D. A. Shirley (Univ. of California, Berkeley). Phys. Rev., 128: 1733-40(Nov. 15, 1962). (UCRL-10202(Rev.))

Hyperfine structure, apparently of pure quadrupolar form, has been observed in the Eu^{3+} ion in a neodymium ethylsulfate lattice. It has twice the predicted magnitude and opposite sign to that calculated on the basis of a pure ground electronic configuration of the type $4f^n$. Arguments are presented for ascribing the anomaly to the admixing, through the crystal-field potential, of the state $5p^5 6p\ ^1D_2$ into the closed-shell state $5p^6\ ^1S_0$. For Eu^{152}, $P_{152} = -(6.7 \pm 0.5) \times 10^{-4}$ cm^{-1} and for Eu^{154}, $P_{154} = -(8.3 \pm 0.7) \times 10^{-4}$ cm^{-1}. The spin and parity assignments of 2− for the 1531-kev state in Sm^{152} and the 1400- and 1723-kev states in Gd^{154}, as well as the electric dipole multipolarities of the radiations depopulating these states, are confirmed. The quadrupole moment of Eu^{154} is found to be 3.29 ± 0.37 b. (auth)

661 COLLISIONAL EXCITATION TRANSFER TO THE 4 ^{1}D STATE IN HELIUM BY MULTIPLE STATE MECHANISM. Chun C. Lin and Robert M. St. John (Univ. of Oklahoma, Norman). Phys. Rev., 128: 1749-53(Nov. 15, 1962).

The electron excitation function of the 4 ^{1}D state of helium has been measured at various pressures by means of an automatic processing system. The peak of the curve shifts gradually from 50 ev to 100 ev as the pressure is increased due to the collision transfer from the ^{1}P states. The transfer can be explained by the multiple state mechanism. Based on this theory the calculated population of the 4 ^{1}D state at 7.4×10^{-2} mm pressure agrees quite well with experiments. The observed amount of transfer from n ^{1}P states to 4 ^{1}D and to 4 ^{3}D are of the same order of magnitude as predicted by the theory. The results of this work provide strong support for the multiple state transfer process. (auth)

662 POLARIZATION OF THE λ = 5876 Å AND λ = 6679 Å LINES IN HELIUM EXCITED BY ELECTRONS. Robert H. McFarland and Edward A. Soltysik (Univ. of California, Livermore). Phys. Rev., 128: 1758-60(Nov. 15, 1962). (UCRL-6929)

The polarization of the lines λ = 5876 Å and λ = 6679 Å resulting from the excitation of helium by electrons was measured as a function of the bombarding electron energy. The dependence of the polarization on the helium pressure is also reported for these lines. The observations reported here conflict with the theory of the polarization of collision-induced radiation at the threshold energy for excitation. (auth)

663 STATISTICAL MECHANICS OF OPEN SYSTEMS. Joel L. Lebowitz (Yeshiva Univ., New York) and Abner Shimony. Phys. Rev., 128: 1945-58(Nov. 15, 1962).

Kubo's treatment of isolated nonequilibrium systems is generalized to open systems in contact with thermal reservoirs. When the system is in contact with one reservoir and is subject to a weak external field, the deviation of the average of any quantity from its equilibrium value is related to a time-correlation function which incorporates the effect of the reservoir. A corollary is an isothermal fluctuation-dissipation theorem, which gives an explicit expression in terms of a time-correlation function for the rate at which energy flows from the driving field into the reservoir via the system. As an application, the complex conductivity of a Lorentz gas is calculated. An expression is also obtained for the stationary nonequilibrium distribution of a system in contact with several reservoirs at slightly differing temperatures and chemical potentials. The Onsager coefficients, which relate the heat and particle fluxes to the differences among the reservoir parameters, are then explicitly expressed in terms of suitable time-correlation functions and their symmetry is exhibited. The validity of perturbation theory in finding the linear deviation from equilibrium of the Γ-space ensemble density is also discussed. (auth)

664 VERY FAST DYNAMICAL WAVE PHENOMENON. Richard G. Fowler and James D. Hood, Jr. (Univ. of Oklahoma, Norman). Phys. Rev., 128: 991-2(Nov. 1, 1962).

An unusual luminous wave of 10^8 cm/sec speed moves out from the driver of a plasma shock tube immediately following breakdown, and progagates more than a meter into a field-free region. (auth)

665 THEORY OF BREAKDOWN WAVE PROPAGATION. G. W. Paxton and R. G. Fowler (Univ. of Oklahoma, Norman). Phys. Rev., 128: 993-7(Nov. 1, 1962).

The propagation of electrical breakdown waves in a gas is analyzed by assuming that the wave front of the breakdown wave is an electron shock wave. A simple three-fluid hydrodynamical model is used in which the partial pressure of the electron gas behind the shock zone is the primary source of the motion. A theoretical wave velocity of 2×10^7 m/sec is predicted for an applied field of 10^4 v/m in H_2 at a pressure of 0.2 mm Hg. Since the propagation mechanism of the breakdown wave is mechanical, the model explains propagation equally well into either a positive or negative electric field. Qualitative agreement between theoretical and experimental breakdown wave velocities is obtained. (auth)

666 FLUCTUATIONS OF THE RESISTANCE AND RESISTANCE LEVELS IN THE INTERMEDIATE STATE OF SUPERCONDUCTORS. Bogoljub Lalevic (Franklin Inst. Labs., Philadelphia). Phys. Rev., 128: 1070-6(Nov. 1, 1962).

It is demonstrated that fluctuations of the resistance in the current-induced intermediate region of both hard and soft superconductors are caused by normal or superconducting domain motion. The amplitude and frequency of the resistance fluctuations have been studied as a function of supercooling, and the velocity of the doman boundary propagation estimated. Definite evidence for both stable and unstable resistance (i.e., energy) levels in the intermediate state is reported. The observations made on vanadium and tantalum wires have a bearing on certain aspects of the properties of superconducting solenoids, in particular, the relation of the critical current to the external magnetic field. (auth)

667 ESCAPE MECHANISM OF SECONDARY ELECTRONS IN POLAR CRYSTALS. W. S. Khokley and K. M. Van Vliet (Univ. of Minnesota, Minneapolis). Phys. Rev., 128: 1123-30(Nov. 1, 1962).

A simplified theory for the motion of secondary electrons produced inside a solid by electron bombardment is proposed. The Boltzmann transport equation is solved for scattering due to electron-phonon collisions. Forward scattering is found to be very predominant, and accordingly the

scattering integral is greatly simplified if, further, a constant energy loss per collision can be assumed. Postulating also a form for the internal excitation function, the solution is obtained and applied to calculate the energy distribution, the angular dependence, and the dependence of the total external current on the electron affinity. Despite the oversimplified assumptions the model clearly shows the difference with the theories given for metals by Wolff and others. Several experimental features as observed in MgO are compatible with the theory. (auth)

668 GROUND STATE OF THE HELIUM ATOM. Charles Schwartz (Univ. of California, Berkeley). Phys. Rev., 128: 1146-8(Nov. 1, 1962).

Following a recent attempt to analyze the rate of convergence of Rayleigh-Ritz variational calculations on the ground state of helium, the usefulness of inserting fractional powers of the variables into the conventional Hylleraas series was re-investigated. The results have been very successful: With a 164-term trial function containing half-powers of the variable $s = r_1 + r_2$, we have matched the best eigenvalue obtained by Pekeris, who used 1078 terms of the conventional type. Our extrapolated value for the nonrelativistic eigenvalue is -2.9037243771 a.u., with an estimated uncertainty of about $1/10^{10}$. (auth)

669 MEASUREMENT OF TOTAL CROSS SECTIONS FOR THE SCATTERING OF LOW-ENERGY ELECTRONS BY LITHIUM, SODIUM, AND POTASSIUM. Julius Perel, Paula Englander, and Benjamin Bederson (New York Univ., New York). Phys. Rev., 128: 1148-54(Nov. 1, 1962).

The atomic beam recoil technique has been used to measure the total cross sections for the scattering of electrons by lithium in the energy range of about 1 to 10 ev. In this method, the atom beam is crossfired by a modulated electron beam. Recoil results in a scattering out of the atom beam at the modulation frequency. A phase-sensitive lock-in amplifier is used to detect the atom-scattering signal, which is obtained here from a continuously oxygenated surface ionization detector. The angular resolution of the apparatus at 1 ev for lithium and potassium is approximately 9° and 14°, respectively, in the electron polar scattering angle. The lithium data were normalized to potassium at each energy at which measurements were made, by the use of two simultaneously operating ovens. As a check on the method, total cross-section measurements in the same energy range were made for sodium. These are in good agreement with the results of Brode, as are some absolute determinations made on sodium, potassium, and cesium at several energies. The general shape of the lithium curve is quite similar to that of the potassium curve over the ranges studied. The lithium cross section values vary from about 50 to 70% of the potassium values in the 1- to 10-ev region. There is the appearance of a resonance at about the same energy (1.5 ev) as those observed in the other alkalis. (auth)

670 RANGES OF Be^9 IONS IN GOLD AND ALUMINUM. Charles O. Hower and A. W. Fairhall (Univ. of Washington, Seattle). Phys. Rev., 128: 1163-5(Nov. 1, 1962).

The ranges of Be^9 ions in gold and aluminum have been measured in the energy range 2 to 21 Mev. Pulse height measurements of Be^9 recoils, degraded by various thicknesses of gold or aluminum foil, served as the basis for construction of range-difference curves. These curves were extrapolated to zero energy and transformed into the more useful range-energy relationships. (auth)

671 ENERGY LOSS AND EFFECTIVE CHARGE OF He, C, AND Ar IONS BELOW 10 Mev/amu IN GASES. F. W. Martin and L. C. Northcliffe (Yale Univ., New Haven). Phys. Rev., 128: 1166-74(Nov. 1, 1962). (TID-16255)

The energy loss associated with the passage of typical heavy ions through various gases has been measured as a function of gas thickness. The ions enter an absorber cell with initial energies of about 10 Mev/amu, held fixed by a magnetic analyzer; the final energy of the ions is determined by analyzing the emergent beam with a magnetic spectrograph. Range-energy curves are obtained for He, C, and Ar ions in H_2, N_2, and Ar and for C ions in CH_4 and He. Over-all accuracy is about 1%. The mean ionization potentials of H_2, N_2, and Ar are determined to be 18.3 ± 2.6, 79 ± 7, and 190 ± 17 ev, respectively. From the stopping power for C and Ar ions relative to that for He ions, their fractional effective charge is computed. Plots of the square of the fractional effective charge as a function of the ratio of the velocity of an ion to that of its own first K electron are in agreement with similar plots for heavy ions in aluminum and oxygen, with one exception, the case of Ar ions in H_2. (auth)

672 EXACT INTEGRAL RELATIONSHIP IN QUANTUM MECHANICS: APPLICATION TO THE VARIATIONAL METHOD. Edwin M. Roberts (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 128: 1381-3(Nov. 1, 1962). (LADC-5368)

An external parameter is, by definition, a quantity which may be varied independently of the coordinate positions and of the momenta of the various particles composing the system. Thus, the Schrödinger equation, for a particular value of the external parameter, belongs to a family of differential equations obtained by varying the numerical value of the external parameter. An explicit example of an external parameter is an imposed magnetic field. The way in which the energy changes throughout the family of Schrödinger equations is given by the Hellmann-Feynman theorem. An exact integral relationship, involving a pair of external parameters, is derived from the Hellmann-Feynman theorem using assumptions which are not unduly restrictive. This relationship is used to arrive at trial (variational) wave functions for quantum mechanical problems which are not exactly soluble. The method is demonstrated in two sample problems. A technique for progressively improving variational calculations is discussed. (auth)

673 HIGH PRESSURE BEHAVIOUR OF SOLID HELIUM. L. N. Simcox and N. H. March (Sheffield Univ., Eng.). Proc. Phys. Soc. (London), 80: 830-8(Oct. 1, 1962).

Approximate self-consistent calculations on solid helium are reported, based on the state $k = 0$. The analytical form of spherical potential thus obtained is employed to calculate the equation of state at very high pressures. Some important electronic eigenvalues are also discussed as a function of the lattice parameter for a face-centered cubic crystal, both the Wigner-Seitz cellular method and an expansion in plane waves being used. The results indicate that a transition to a metallic state would occur at a pressure of approximately 10^3 atmospheres. This is a factor of 2 lower than an earlier estimate made by ten Seldam in 1957. (auth)

674 A PERTURBATION TREATMENT OF THE UNRESTRICTED HARTREE–FOCK EQUATIONS FOR THE GROUND STATE OF LITHIUM-LIKE IONS. C. S. Sharma (Oxford Univ.). Proc. Phys. Soc. (London), 80: 839-48 (Oct. 1, 1962).

The unrestricted Hartree-Fock integro-differential equations for the ground state $1s^2 2s\ ^2S$ of lithium-like ions are solved by a perturbation expansion in ascending powers of $1/Z$. The zero- and first-order functions are obtained

analytically and energies up to the third order are calculated. These are compared with the corresponding expansion for the restricted Hartree-Fock energy, obtained by Linderberg (1961). Some of the difficulties in using these functions for calculating the hyperfine splitting are briefly discussed. (auth)

675 COMMENTS ON THE NEUTRON SPECTRUM OF FERROELECTRIC AND PARAELECTRIC $BaTiO_3$. I. Lefkowitz (Cavendish Lab., Cambridge, Eng.). Proc. Phys. Soc. (London), 80: 868-72(Oct. 1, 1962).

Insight into ferroelectric phenomena has been gained using lattice dynamical arguments. Early infrared measurements were misleading. More recent infrared and neutron work coupled with the theoretical results of Kurosawa permit the assignment of L.O. and T.O. modes that are in good agreement with peaks observed in the neutron spectrum of $BaTiO_3$. (auth)

676 BORON NUCLEAR MAGNETIC RESONANCE IN RARE EARTH INTERMETALLIC COMPOUNDS. A. C. Gossard and V. Jaccarino (Bell Telephone Labs., Murray Hill, N. J.). Proc. Phys. Soc. (London), 80: 877-81(Oct. 1, 1962).

B^{11} nuclear magnetic resonance has been observed in a series of rare earth hexaboride intermetallic compounds (LaB_6, CeB_6, PrB_6, NdB_6, SmB_6, GdB_6, DyB_6, HoB_6, as well as ScB_6 and YtB_6) above their magnetic transition temperatures. Shifts in the field for resonance of the B^{11} nuclei were found which depended in sign and magnitude of the magnetic properties of the rare earth atoms. The shifts are qualitatively similar to, but smaller than, the Al^{27} shifts previously observed in rare earth aluminum compounds. The results in both series of intermetallic compounds can be explained by the exchange interaction between localized rare earth ion core moments and conduction electrons, which results in a magnetic polarization of the conduction electrons and thus in a shift in the field for resonance. (auth)

677 PRIMARY IONIZATION COEFFICIENT OF HELIUM. D. Kenneth Davies, F. Llewellyn Jones, and C. G. Morgan (University Coll., Swansea, Eng.). Proc. Phys. Soc. (London), 80: 898-908(Oct. 1, 1962).

Ionization currents in spectroscopically pure helium between plane parallel silver electrodes at separations up to 0.75 cm were measured in the range $6 \leq E/p \leq 100$ v cm^{-1} mm Hg^{-1} and $3 \leq p \leq 115$ mm Hg where E is the applied electric field and p the gas pressure. The values of the primary ionization coefficient α/p deduced from these measurements were lower than previously published experimental values, particularly at the lowest range of E/p. Within the limits of experimental error α/p was found to be a function of E/p only. The values of α/p were in good agreement with the values calculated by Dunlop in 1949, by Abdelnabi and Massey in 1953, and by Phelps in 1960. This result suggests that the Smit distribution of electron velocities, Maier-Leibnitz's inelastic collision cross section data, and Nielsen's electron mobility values are applicable to the data. (auth)

678 BREAKDOWN OF AN ELECTRODELESS DISCHARGE IN CROSSED ELECTRIC AND MAGNETIC FIELDS. S. N. Sen and A. K. Ghosh (Jadavpur Univ., Calcutta). Proc. Phys. Soc. (London), 80: 909-17(Oct. 1, 1962).

The variation of breakdown potential in an electrodeless discharge has been studied in air in a discharge tube of length 9 cm, the pressure varying from a few microns to 300 microns and the magnetic field from 20 gauss to 200 gauss, the discharge being excited by means of a transformer (10 kv). The breakdown voltage is always found to be higher than when no magnetic field is present for all values of pressure, and the pressure at which the breakdown voltage becomes a minimum increases gradually as the magnetic field is increased. It is observed that the expression for equivalent pressure, as deduced by Blevin and Haydon in 1958, can explain the observed results at low pressure and for low values of magnetic field (below 50 gauss), but for higher magnetic fields the variation of Townsend's second coefficient in a magnetic field also has to be taken into consideration. Consequently a new expression for V_{SH}, the breakdown voltage in crossed electric and magnetic fields, has been deduced, taking into consideration the effect of both the equivalent pressure and the variation of Townsend's second coefficient in a magnetic field. This new expression can explain not only the increase of breakdown voltage in a magnetic field for all values of pressure, but can account satisfactorily for the shift of pressure for minimum breakdown voltage as the value of magnetic field is gradually increased. (auth)

679 THE MAGNETOCRYSTALLINE ANISOTROPY OF GADOLINIUM. W. D. Corner, W. C. Roe, and K. N. R. Taylor (Univ. of Durham, Eng.). Proc. Phys. Soc. (London), 80: 927-33(Oct. 1, 1962).

Measurements of the magnetocrystalline anisotropy constants have been made on a single crystal of gadolinium using a torque magnetometer. The apparatus used is briefly described and the application of corrections for lack of saturation and for a paramagnetic component are explained. Measurements have been made between 37.5°K and 315°K and it is found that three constants are required to represent the results. It is shown that at temperatures greater than 240°K the easy direction is the hexagonal axis. Below this temperature the easy direction lies on a cone whose axis is the c axis, and the variation of cone angle with temperature is calculated from the values of the anisotropy constants. (auth)

680 THE WORK FUNCTION OF FILMS EVAPORATED FROM URANIUM CARBIDE. B. H. Blott and B. J. Hopkins (University of Southampton, Eng.). Proc. Phys. Soc. (London), 80: 989-91(Oct. 1, 1962).

Measurements of the collector work function during the early stages of the uranium carbide cathode life are reported. The variation with time of the collector work function as material evaporated from a cathode maintained at 1850°K is tabulated. The collector was Mo. In a second experiment, again with a Mo collector, the cathode temperature was increased to 2150°K, and the time scale was reduced. In the third experiment, a W collector was used and the results obtained were similar to those obtained in the first experiment. Finally, the formation of the film on the W surface was followed with the cathode maintained at 1770°K. It is concluded that even at temperatures as low as 1770°K within five minutes the collector surface becomes covered with a layer of material evaporated from the uranium carbide cathode, which produces a minimum work function of ~3.0 ev. (L.T.W.)

681 THE DIAMAGNETIC SHIELDING OF NUCLEI IN METALS. J. E. Hebborn (Univ. of London) and M. J. Stephen. Proc. Phys. Soc. (London), 80: 991-2(Oct. 1, 1962).

Hebborn (1962) and Stephen (1962) separately considered, by different methods, the problem of the diamagnetic shielding of nuclei by conduction electrons in metals. The first author obtained a result for the shielding constant exact to within the limits of the Bloch model. The second author obtained an expression (exact again in the Bloch model) for

the volume current density induced in a metal by a uniform magnetic field. The volume current density can be used to calculate the shielding constant. It is shown that the results obtained by the two authors are identical. The expression for the volume current density given by Stephen leads, for the case of a metal with a center of symmetry (the case considered by Hebborn), to the result for the shielding constant obtained by Hebborn. (L.T.W.)

682 ON CERTAIN REGULARITIES IN THE PASSAGE OF ELECTRONS THROUGH SOLIDS. A. Ya. Vyatskin and A. N. Pilyankevich (Leningrad Inst. of Precision Mechanics and Optics). Soviet Phys.-Solid State (English Transl.), 4: 765-9(Oct. 1962).

A method of determining the characteristics of electron retardation in thin solid films is considered in connection with the theoretical characteristics. Approximation of electron paths by a power law is discussed. The so-called "normalization" of transmitted-current curves is considered. (auth)

683 GAMMA- AND PHOTOELECTRIC PROPERTIES OF CADMIUM SULFIDE. P. G. Litovchenko and V. I. Ust'yanov (Inst. of Physics, Kiev). Soviet Phys.-Solid State (English Transl.), 4: 773-4(Oct. 1962).

An experimental study of the gamma-conductivity and photoconductivity response spectra of cadmium sulfide crystals is reported. A possible relation between these two properties is discussed. (auth)

684 THE PHOTOELECTRIC EMISSION OF POSITIVE IONS FROM AN ADSORPTION LAYER. H. Moesta (Universität, Bonn). Z. Naturforsch., 17a: 578-84(July 1962). (In German)

A photoelectric effect with positive ions, which can be observed on a layer of potassium adsorbed on platinum, is reported. In the irradiation of such a layer the thermal ion current flowing from the surface of the platinum is altered. In certain regions of the energy distribution, the ions emitted cause a photoemission, supplementary to the thermal emission. In other regions of the energy distribution, the reduction of the thermal ion current produced by the light can be observed. Both effects occur at wave lengths larger than those necessary for the ionization of potassium in the gaseous phase. The apparatus is described and the results are discussed. (tr-auth)

685 EFFECTIVE PARAMETERS FOR ATOM AND ION ELECTRON ORBITS. V. S. Urusov (Inst. of Geochemistry and Analytical Chemistry, USSR). Zh. Strukt. Khim., 3: 437-47(July-Aug. 1962). (In Russian)

Empirical effective parameters, based on the experimental data, of ionization potentials and x-ray terms are suggested for atom and ion orbits (with effective quantum numbers and charges). The effective constants are utilized in evaluating the external screening. Both effective parameters transform into variable magnitudes in consecutive transitions from one atom to another within one electron shell. Electron shell dimensions are evaluated and compared with experimental atomic and ionic radii. Data on β electrons are in good agreement with Hartree-Fock results. The suggested effective parameters can be utilized in atom and ion wave approximation functions. (tr-auth)

686 APPLICATION OF SPARK DISCHARGE AS SOURCE OF INTENSE 10^{-7} TO 10^{-8} SEC. LIGHT SPARKS. III. INVESTIGATION OF CAPILLARY, SURFACE AND DAMPING RESISTANCE OF THE SPARK DISCHARGE IN AIR. S. I. Andreev. Zh. Tekhn. Fiz., 32: 967-74(Aug. 1962). (In Russian)

Physical processes in capillary, surface, and damped resistance in high-power, nanosecond spark discharge were investigated. (R.V.J.)

687 ELECTRODE EROSION BY HIGH DENSITY ELECTRIC DISCHARGE. V. E. Il'in and S. V. Lebedev (Lebedev Moscow Inst. of Physics). Zh. Tekhn. Fiz., 32: 986-92(Aug. 1962). (In Russian)

An analysis was made of the mechanism of electrode erosion, and it was postulated that erosion is caused by Joule heating. It is shown that at $J > 10^6$ amp/cm^2, Joule's model correctly describes the quantitative erosion process. (tr-auth)

688 ANGULAR DISTRIBUTION OF SPUTTERED PARTICLES BY ION BEAM IRRADIATION OF SINGLE CRYSTALS. G. Endzheets, V. A. Molchanov, V. G. Telkovskii, and M. A. Faruk (Moscow State Univ.). Zh. Tekhn. Fiz., 32: 1032-3(Aug. 1962). (In Russian)

Measurements were made of angular distributions of particles sputtered in Cu and Ni monocrystal irradiation by Ar^+ and Ne^+ beams. The irradiated surfaces did not exceed 8 mm; target and collector were 95 mm apart at 100°C. Diagrams of sputtering coefficients as functions of ion incidence angle are given. (R.V.J.)

689 REGULAR FRONT INTERACTIONS OF PLANE SHOCK WAVES. S. M. Ter-Minasyants. Zh. Vychislitel. Mat. i Mat. Fiz., 2: 351-8(1962). (In Russian)

An analysis is made of plane shock wave interactions in ideal gas. It is postulated that behind the rectilinear propagating wave fronts the gas motion parameters are constant and the fronts shift toward each other at a constant angle $\varphi < \pi$. The examined problem comprises the generalization for oblique wave reflection from the wall. The numerical solution is derived by means of a computer. (R.V.J.)

690 SOLID HELIUM^3 BELOW 1°K. John Lewis Baum. Thesis, Columbus, Ohio, Ohio State Univ., 1961. 143p.

The melting curve of He^3 was determined from 0.06 to 0.70°K by measuring the pressure and temperature of an equilibrium mixture of the solid and liquid confined in a vessel. The pressure was measured by a strain gage cemented to the wall of the vessel. The melting pressure was found to have a minimum of 29.25 ± 0.01 atm at 0.32 ± 0.01°K. The entropy of the solid was calculated from the slope of the melting curve and other data, and above 0.30°K was found to be within 0.02 cal/deg-mole of the maximum theoretical value of the spin entropy, R ln 2; at lower temperatures it decreased. The specific heat of the solid was measured in the same apparatus from 0.2 to 0.4°K, at 40 and ~100 atm. It was found to be less than 10^{-3} R. The "paramagnetic" Curie temperature T_c was calculated from the melting curve data and from the specific heat data, and compared with values determined by nuclear resonance. Values ranged from 0.005 to 0.08°K; it was believed to be ~0.01°K. (Dissertation Abstr., 22: No. 7, 1962.)

Astrophysics and Cosmology

691 (AFOSR-2958) ON THE STEADY-STATE DYNAMICS OF SPIRAL GALAXIES. Scientific Report No. 3. Howard D. Greyber (Northeastern Univ., Boston). June 1, 1962. Contract AF49(638)-555. 40p.

A proposed model of the steady state dynamics of spiral galaxies based on astronomical data and analyses of the physical processes involved in such galaxies is presented. Results of a theoretical investigation concerning a general dipole magnetic field in the region close to the center of the

galaxy (whose axis roughly coincides with that for the galaxy) are given. It is noted that the model is not inconsistent with data and with reasonable estimates of the gravitational and magnetohydrodynamic effects involved. (J.R.D.)

692 A POSSIBLE MECHANISM OF SOLAR FLARES. V. S. Komel'kov. Dokl. Akad. Nauk SSSR, 146: 58-61 (Sept. 1, 1962). (In Russian)

The properties of magnetohydrodynamic vortices were reviewed in order to explain the origin of solar flares. The nature of the gas (air, hydrogen, argon), ionization of the gas, and the pressure do not affect the structure of the vortex. In addition to a field H_ϕ created by the longitudinal current loop, a field H_z, which is formed by twisting a part of the longitudinal current into a spiral, exists coaxially within the plasma. The diameter of the spiral increases sharply on entering a medium of lesser density. The plasma of the current loop, which is compressed between the crossed fields H_ϕ and H_z, is highly stable and separates into small plasmoids which are stable in structure. The longitudinal velocity of a jet stream exceeds the transverse velocity by a factor of 3 to 5, and is similar to a fountain in form. The current loop emits a continuous spectrum. The temperature of the outer plasma is 3 ev, and that of the current loop is 30 ev. The x-ray emission from the current loop has an energy of 200 to 250 kev at a potential of 10 to 20 kv. The electron acceleration causing the x-ray emission takes place with changes in the field H_z. A jet stream with a current of 3 to 10 ka can penetrate a longitudinal field of up to 50 koerst. due to the fountain structure. These facts can be correlated with observations on sun-spot activity. For example, the fact that each solar flare is accompanied by a solar protuberance, but not each protuberance gives a solar flare can be explained by the separation of a vortex from the cold mass of a protuberance. A separate vortex can result in the formation of shock waves and flares. The velocity of a solar flare is close to that observed in experimental, plasma jet streams (10^5 to 5×10^7 cm/sec). The time of existence of a solar flare (10^2 to 10^4 sec) can be correlated with the time of existence of plasma jet streams. (TTT)

693 THE THERMAL BALANCE OF THE IONOSPHERIC F-REGION. C. H. Cummack (Geophysical Observatory, Christchurch, N. Z.). J. Atmospheric and Terrest. Phys., 24: 691-9(Aug. 1962).

An atmospheric heat equation is derived for the case in which the atmosphere is heated by the absorption of ionizing radiation and cooled by conduction and radiation. A formal solution is given when the thermal conductivity varies as the first power of the temperature. (auth)

694 LARGE-SCALE AURORAL MOTIONS AND POLAR MAGNETIC DISTURBANCES. II. THE CHANGING DISTRIBUTION OF THE AURORA DURING LARGE MAGNETIC STORMS. S. I. Akasofu (Univ. of Alaska, College). J. Atmospheric and Terrest. Phys., 24: 723-7(Aug. 1962).

A feature of magnetic storms with a large main phase is that auroras appear in lower latitudes than usual. During a considerable part of the two storms of 23 September 1957 and 11 February 1958, the usual region of most frequent aurora was deserted. A temporary equatorward shift of the northern border of auroral activity was indicated. It was shown that the range of latitude in which auroras appear overhead intermittently expands and contracts; these changes were discussed in relation to the polar magnetic sub-storms. Red glows, seen occasionally in low and middle latitudes during large magnetic storms, become more intense as the activity of polar magnetic sub-storms increases. (auth)

695 UNIVERSAL NEUTRINO DEGENERACY. Steven Weinberg (Imperial Coll. of Science and Tech., London). Phys. Rev., 128: 1457-73(Nov. 1, 1962).

Modern cosmological theories imply that the universe is filled with a shallow degenerate Fermi sea of neutrinos. In the steady state and oscillating models (and perhaps also the "big bang" theories) it can be shown rigorously that the proportion of filled neutrino levels (plus the proportion of filled antineutrino levels) is precisely one up to a finite Fermi energy E_F. The proof takes into account both absorption and the repressive effects of already filled levels on neutrino emission. Experiment shows that $E_F \leq 200$ ev for antineutrinos and $E_F \leq 1000$ ev for neutrinos. The degenerate neutrinos could be observed (if $E_F > 10$ ev) by looking for apparent violations of energy conservation in β^- decay. In the steady state and evolutionary cosmologies E_F is much too low to ever be observed, but in the oscillating cosmologies $E_F \simeq 5R_c$ Mev, where R_c is the minimum radius of the universe in units of its present radius; thus experiment already shows that the universe will contract by a factor over 10^3, if at all. Astronomical evidence plus Einstein's field equation (without cosmological constant) require in an oscillating cosmology that $E_F < 2 \times 10^{-3}$ ev (so $R_c < 10^{-9}$) and suggest that higher energy neutrinos may represent the bulk of the energy of the universe. A model universe incorporating this idea is constructed. (auth)

696 COSMOGENIC Mn^{53}, Al^{26}, AND Be^{10} IN IRON METEORITES AND A SEARCH FOR TERRESTRIAL Mn^{53}. Julian Paul Shedlovsky. Thesis, Princeton, N. J., Princeton Univ., 1961. 142p.

Three long-lived radionuclides, Al^{26} ($t_{\frac{1}{2}} = 8 \times 10^5$ yr), Be^{10} ($t_{\frac{1}{2}} = 2.7 \times 10^6$ yr), and Mn^{53} ($t_{\frac{1}{2}}$ 1.3×10^5 yr), were isolated from three iron meteorites, and their specific activities determined with a β flow counter. Radiochemical purification was performed. An absorption curve was determined for the Al^{26} and Be^{10} samples from one of the meteorites as a further criterion for radiochemical purity. The gamma activity of the Mn^{53} samples was found to be negligible, assuring that they were not contaminated with Mn^{54}. The production rates of a number of nuclides, both stable and radioactive, in an iron meteorite were calculated. The integral star size distribution in iron, produced by cosmic rays, was measured and approximated by the expression $N_p = e^{-\delta p}$, where p was the number of prongs for a given star. Assuming that only singly (83%) and doubly (17%) charged prongs were produced, the element yield per star was calculated. The isotopic yield distribution for each element produced was calculated. The absolute production rates were then calculated from measured inelastic proton cross sections and the flux of cosmic radiation. The cosmogenic star production rate as a function of depth in spherical iron meteorites was estimated from cross section-vs-depth measurements of Ar^{37} production in iron by high energy protons. From these curves and the measured Be^{10}, Al^{26}, and Mn^{53} activities in the meteorites, their preatmospheric sizes were estimated. The cosmic ray exposure ages of the meteorites were calculated from the measured K^{40}/Be^{10} activity ratio compared to the predicted production ratio. Because the steady-state tritium inventory on earth may be significantly greater than can be explained by cosmic-ray production, the hypothesis of solar accretion of tritium was examined. If production of tritium in the solar corona can take place, then other simple nuclear reactions should also occur. One of these, $Fe^{56}(p,\alpha)$ Mn^{53}, leads to Mn^{53} production. A search for this isotope

was made in manganese nodules. An estimate of the possible specific activity of Mn^{53} was calculated to be 2 dpm/gm Mn. A liquid scintillation counter was used to detect the Mn^{53} decays and the Mn^{53} specific activity of a manganese nodule measured as -8.6 ± 4.6 dpm/gm Mn. This result did not categorically reject the solar accretion hypothesis. (Dissertation Abstr., 22: No. 7, 1962.)

Cosmic Radiation

697 (JPRS-15524) RESULTS OF COSMIC RADIATION RESEARCH IN HUNGARY. Translated from Fiz. Szemle, 12: No. 5, 138-43(1962). 16p.

A review of efforts devoted to cosmic radiation investigation is given in which an outline of radiation research beginning in 1930 is presented. It is noted that after an initial period, interest was focused on interactions of high-energy particles and nuclei, and on cosmic radiation intensity fluctuations. The investigation concerning meson generation and nuclear structure based on high-energy interactions is in its initial phase. The most significant result in cosmic radiation fluctuation investigation is the 27-day periodicity of the mu-meson component. (J.R.D.)

698 COSMIC RAY FLARES ASSOCIATED WITH THE 1961 JULY EVENT. M. A. Ellison, Susan M. P. McKenna, and F. H. Reid (Dublin Inst. for Advanced Studies). Monthly Notices Roy. Astron. Soc., 124: 263-74(June 1962).

Four major flares are considered in relation to their acceleration of high-energy (>1 Bev) protons toward the earth. All are associated with the complex spot group that crossed the central meridian on July 14, 1961. The flares of July 12 and 18, recorded with a heliograph, are compared and their light-curves in Hα are given. These flares are comparable in importance and similar in other respects; yet the second generates a shower of high-energy protons, recorded by their secondary effects at ground level, while the first does not. The reasons for this difference are considered in terms of the magnetic field situation in the sun-earth space during the passage of the spot group across the solar disk. The flare of July 12 occurs at a time when the terrestrial environment is relatively free from magnetized plasmas; but by July 18 the earth is enveloped by a radial magnetic field (magnetic bottle) reaching from the solar active region beyond the earth's orbit. The flares of July 18 and 20 thus find ready-made trajectories for the transport of their high-energy protons to the earth. Heliographic co-ordinates are given for the 12 flares known to have produced cosmic ray effects at ground level. The asymmetry of their positions on the solar disk is such as to suggest the existence at these times of radial magnetic fields, which connect sun to earth and have their lines of force bent convex to the west by solar rotation. (auth)

699 ENERGY SPECTRUM AND POSITIVE EXCESS OF MUONS IN COSMIC RAY AIR SHOWERS. Stewart Bennett. Thesis, Ithaca, N. Y., Cornell Univ., 1961. 64p.

A magnetic spectrometer and an array of 15 large plastic scintillators with photomultipliers are used to investigate the muon component of cosmic ray air showers. The spectrometer can resolve muon momenta smaller than about 20 Bev/c. The scintillators, each of area 0.87 m^2, are spread over an area of about one square kilometer. A calculational procedure involving a priori assumptions of the muon and charged-particle lateral distributions is developed, and fits the data for muons of energy ≥1 Bev. It is also possible to determine the muon density as a function of muon energy. It is concluded that the mean energy of muons in air showers is 6.9 Bev. The total energy in the muon component is calculated. The sense of the curvature of the muons in the spectrometer is used to determine the sign of the charge. For muons associated with air showers, the positive excess η,η being defined as the difference between the numbers of positive and negative muons divided by their sum, is measured to be 0.002 ± 0.039. For muons not associated with air showers, η is found to be 0.088 ± 0.025. It is concluded that in nuclear interactions where the secondary mesons are given 5 to 10 Bev, π meson production greatly dominates over K meson production. (Dissertation Abstr., 22: No. 7, 1962.)

700 VERTICAL TRANSPORT OF ELECTRONS IN THE F-REGION. Sushil Chandra. Thesis, University Park, Penna., Pennsylvania State Univ., 1961. 95p.

The continuity equation of electron density is solved to yield an expression for the vertical transport, which can be evaluated from electron-density, true-height profiles. A few numerical computations are presented for the vertical drift velocities determined for stations at Huancayo, Talara, Panama, and Washington, D. C. It is shown that the velocity is predominantly downward during the night and upward during the day at the equatorial stations. There is an apparent phase reversal from summer to winter at Washington. The order of vertical velocity amplitude is 25 m/sec. The dynamical equations are derived for the conditions existing in the upper atmosphere, and their solutions are obtained making some appropriate assumptions. It is shown that the semi-diurnal oscillation of the atmosphere is caused by a Coriolis resonance and is independent of any physical property of the atmosphere. A few computations are made for the velocity of electrons using pressure and density data obtained from satellite experiments. The result is in agreement only to an order of magnitude with the values obtained from N-h profiles. (Dissertation Abstr., 22: No. 7, 1962.)

Criticality Studies

701 (ANL-6608) STUDY OF THE SENSITIVITY OF CALCULATIONS FOR FAST REACTORS FUELED WITH Pu^{239}–U^{238} AND U^{233}–Th TO UNCERTAINTIES IN NUCLEAR DATA. A. Gandini (Argonne National Lab., Ill.). Sept. 1962. Contract W-31-109-eng-38. 24p.

The effects of uncertainties of nuclear data on the calculation of integral quantities for some fast breeder systems were evaluated. The integral quantities chosen were reactivity, initial breeding ratio, and initial internal breeding ratio. The fuels chosen were Pu^{239}–U^{238}, both as metal and oxide, and U^{233}–Th as oxide. The importance of propagation of errors on the uncertainty in reactivity was determined. Results indicated that because of inaccuracies in the values of nuclear parameters as known within the present "state of the art" the deviations of the calculated reactivities should be about, and possibly larger than, 2% $\Delta k/k$ for all the medium and large systems considered. The deviation of the initial breeding ratio is 3.5%, and for the initial internal breeding ratio it is about 5%. The consequent uncertainty in the calculated critical mass is of the order of 4%. (M.C.G.)

702 (ANL-6617) A CRITICAL COMPARISON OF MEASURED AND CALCULATED FISSION RATIOS FOR ZPR-III ASSEMBLIES. W. G. Davey (Argonne National Lab., Idaho Falls, Idaho). Sept. 1962. Contract W-31-109-eng-38. 35p.

A critical comparison of measured and calculated central fission ratios for 18 ZPR-III fast reactor assemblies was

made with the object of examining the accuracy of computation of spectra and of the fission cross sections used. This comparison uses fission ratios measured with Kirn absolute fission chambers and computed with ANL cross section Set 635. The Kirn chambers and experimental technique are described. It is shown that ratios measured with threshold detectors must be corrected for the effects of inelastic scattering in the chamber walls. Possible sources of error in the experimental technique are discussed, and experimental evidence for the validity of the method is presented. The derivation of ANL Set 635 is described. It is shown that Set 635 is a modification of the Yiftah, Okrent, and Moldauer ANL Set 135 and that the central spectra and fission ratios calculated with the two sets are generally similar. The U^{234} and U^{236} fission cross sections are not given in Sets 135 and 635; these were taken from ANL Set 179. The measured and calculated fission ratios obtained with U^{233}, U^{234}, U^{235}, U^{236}, U^{238}, Pu^{239}, and Pu^{240} were compared, both to search for trends which might occur with progressive changes in spectra, and also to determine the accuracy of prediction of ratios. It was found that the calculated relative fission rates of Pu^{239} and U^{233} are within about $\pm 1\frac{1}{2}\%$ of the measured values, and the calculated rates for Pu^{240}, U^{236}, and U^{238} relative to either Pu^{239} or U^{233} are within $\pm 3\frac{1}{2}$ to $\pm 5\%$ of the measured values. However, calculated fission rates for U^{235} and U^{234} are about 6% low and 8% high, respectively, relative to those of the other five isotopes. (auth)

703 (WAPD-T-1459) CALCULATION OF COMPLEX NATURAL MODES FOR SPATIAL XENON OSCILLATIONS AND COMPARISON WITH A SIMPLE APPROXIMATION. R. L. Ewen (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). June 1962. Contract [AT-11-1-GEN-14]. 16p.

Complex natural modes associated with spatial xenon oscillations were calculated for a series of cores in slab geometry and compared with the approximation to these modes suggested by Harris and Lacy. The good agreement obtained for both damping factor and frequency is of considerable importance in view of the simplicity of the approximate method and the fact that in many cases it may be applied to detailed core descriptions using existing diffusion codes. (auth)

Elementary Particles and Radiations

704 (AWRE-0-64/60) THE PREPARATION OF GAMMA RAY SCATTERING DATA FOR USE IN GAMMA RAY TRANSMISSION PROBLEMS ON HIGH SPEED COMPUTERS. B. R. S. Buckingham and E. D. Pendlebury (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). May 1961. 22p.

The AWRE Punched Card Library of γ scattering data is described. It is arranged on similar lines to the AWRE Library of Neutron Cross Sections. Full details of the card layouts are given. (auth)

705 (BNL-6181) A NEEDLE IN A HAYSTACK. J. Bernstein (Brookhaven National Lab., Upton, N. Y.) and G. Feinberg (Columbia Univ., New York). May 25, 1962. Contract [AT-30-2-GEN-16].

Production of ρ's and ω's in $\pi^- + p$ and $p + \bar{p}$ interactions is discussed. The ρ is presumably a $J = 1^-$, $I = 1$ state and thus can decay into 2π's via a strong coupling. The ω is probably $J = 1^-$, $I = 0$ which can also decay into 2π's via electromagnetic coupling. A theoretical description of this situation is presented in terms of coupled time-dependent Schrödinger equations which mix ρ and ω states that are assumed to be isotopically pure at the time of production. The interference between the two resonances was found to have the effect of extending the 2π spectrum toward the ω mass. (M.C.G.)

706 (BNL-6214) THE K^--p INTERACTION AT 2.24 Bev/c. I. EFFECTIVE MASS DISTRIBUTIONS. L. Bertanza, V. Brisson, et al. (Brookhaven National Lab., Upton N. Y.); M. Goldberg, et al. (Syracuse Univ., N. Y.). [1962]. Contract [AT-30-2-GEN-16]. 23p.

Results based on the 2 and 3 particle effective mass distributions of selected production channels from K^--p interactions at 2.24 Bev/c are discussed. The experimental distributions show that the production of resonant states is still important at higher energies. Preliminary information concerning the resonant states K^*, Y^*, ω, and Y_m^*, m = 1500 is included. (J.R.D.)

707 (BNL-6232) ANTIPROTON-PROTON TWO-PRONG INTERACTIONS AT 3.25 Bev/c. T. Ferbel, J. Sandweiss, H. D. Taft (Yale Univ., New Haven); B. B. Culwick, M. Gailloud, T. W. Morris, A. M. Thorndike (Brookhaven National Lab., Upton, N. Y.); R. M. Lea (City Coll., New York); and T. E. Kalogeropoulos (Columbia Univ., New York). [1962]. Contract [AT(30-2)-Gen-16]. 13p.

A study is being made of two-prong antiproton interactions in hydrogen at 3.25 Bev/c. About 2250 two-prong events were measured on automatic digitized machines and their reconstruction and analysis were performed with standard programs. Of the total number of events 1003 were classified as elastic interactions. About 500 inelastic events were examined using bubble density estimates in addition to criteria based on distribution values in the classification procedure. The inelastic events in which a secondary nucleon or antinucleon was unambiguously identified were used to obtain limits for annihilation and non-annihilation partial cross sections. The two-prong events were 57% of the total. Results for angular distributions and cross sections are presented in graphs and tables. (M.C.G.)

708 (CERN-62-20) LECTURES ON WEAK INTERACTIONS. CERN Seminars, 1961. (European Organization for Nuclear Research, Geneva). June 18, 1962. 104p.

Twelve lectures are included which treat various topics in particle physics. The topics include information on the Dirac equation, projection operators, cross section for weak e-ν scattering, electromagnetic theory, conserved vector current theory, positive pion decay, form factors, strange particle interactions, mesons (K^+) and (K^0) decays, isotopic properties for weak interaction current, $|\Delta\vec{I}| = \frac{1}{2}$ rule in non-leptonic decays of strange particles, and leptonic decay rates of the hyperons within the framework of the universal Fermi interaction. (N.W.R.)

709 (IFA/EM/47) ON THE ENERGY SPECTRUM OF γ-RAYS FROM HIGH ENERGY NUCLEAR COLLISIONS. PART I. ESTIMATION OF PHOTON ENERGIES. PART II. COMPARISON OF PHOTON SPECTRA FROM PROTON AND PION INTERACTIONS. E. M. Friedlaender, E. Gombosi, M. Marcu, and M. Spirchez (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). 1962. 6p.

An investigation to determine the value of measuring projected angles of electron pairs to obtain information concerning π^0 energy spectra is described. Methodological aspects of this process are presented, and information concerning the relative spreads of angular and scattering

energy estimates is included. The experimental results on large samples of electron pairs are presented and discussed. (J.R.D.)

710 (LAMS-2740) THE SCATTERING OF NON-RELATIVISTIC SYSTEMS WITH ARBITRARY SPIN. Arthur Kerman (Los Alamos Scientific Lab., N. Mex.). Sept. 15, 1961. Contract W-7405-eng-36. 65p.

The problem of the scattering of nonrelativistic systems with arbitrary spin is considered using the standard spherical tensor methods. The polarization, depolarization, and polarization transfer tensors are defined and exhibited explicitly in terms of the phase shifts. Tensor expansions are also made for the scattering aptitude itself, and some examples are considered. (auth)

711 (NEVIS-110) COMPARISON OF η, τ, AND τ' DECAYS. D. Berley, D. Colley, and J. Schultz (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). Oct. 1962. Contract AT(30-1)-1932. 10p. (CU-216)

A comparison of the pion spectra from η, τ, and τ' decays was made. The data were in good agreement with the assumptions that, the pions from τ and τ' decays are in a state with isotopic spin 1; and the η and τ' decays proceed through a one pion intermediate state. (auth)

712 (NRL-5838) SOME EXACT SOLUTIONS TO THE THREE-DIMENSIONAL EQUATION OF RADIATIVE TRANSPORT. W. R. Faust (Naval Research Lab., Washington, D. C.). Aug. 17, 1962. 6p.

Fourier techniques were applied to obtain an exact solution of the three-dimensional integrodifferential equation of radiative transport for a point isotropic source imbedded in an infinite medium. Results of these calculations were then extended to obtain the solution for a point source radiating along the z axis (beam of radiation). (auth)

713 (NYO-10247) ON THE KINEMATICS OF THE RELATIVISTIC TWO-PARTICLE SYSTEM. A. J. Macfarlane (Rochester, N. Y. Univ.). Sept. 24, 1962. Contract AT(30-1)-875. 39p.

The canonical forms that the generators of the infinitesimal transformations of P, the restricted Poincare Group, take when operating within the Hilbert space of states of an arbitrary irreducible representation of P, such as that which affords a kinematic, description of a single relativistic particle, are known. The forms in which they appear when operating within the Hilbert space of states of the reducible direct product representation of P which describes a system of two noninteracting relativistic particles were developed. On introduction of the Clebsch-Gordan (C-G) series of P which expresses the resolution of this latter Hilbert space into a direct integral over the Hilbert spaces wherein operate the irreducible constituents of the direct product representation, it was proved that the generators operate in canonical form within each of these subspaces. The analysis may be viewed as providing a mathematically complete derivation of the general formula for the C-G coefficient of P which was previously derived only on the basis of heuristic physical argument. It was found that in order to see how the intrinsic angular momentum of the two particle system, in a state of given momentum, is compounded from the relative angular momentum and intrinsic spins of the particles, that state must be viewed from a frame of reference wherein it appears to have zero momentum. (auth)

714 (SRB-62-4) SMALL ANGLE X-RAY SCATTERING. AN ANNOTATED BIBLIOGRAPHY. Jack B. Goldmann, comp. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). June 1962. 72p.

A survey was made of literature pertaining to small angle and low angle x-ray scattering emphasizing studies of particle size and determination of surface areas. This bibliography supplements and extends the one included in Guinier, A. and Fournet, G., Small-angle scattering of x-rays (New York, Wiley, 1955) to March 1962. Citations are arranged alphabetically by author. (auth)

715 (TID-16623) STUDY OF PION-HYPERON RESONANCES BY DISPERSION RELATIONS IN THE UNPHYSICAL SHEET. R. C. Hwa and D. Feldman (Brown Univ., Providence). [May 15, 1962]. Contract AT(30-1)-2262. 6p.

An approach to the study of resonances in multi-channel two-particle systems is presented. The approach involves the use of resonance poles in the unphysical sheet of the Riemann surface in the energy variable for the eigenamplitudes. As an application of the formalism, the pion-hyperon resonances are considered, from which various aspects of the nature of the interactions in the pion-hyperon system are determined. (J.R.D.)

716 (TID-16786) THE LIFETIME OF THE Λ^0 HYPERON. J. Auman, M. M. Block, R. Gessaroli, J. Kopelman, S. Ratti (Northwestern Univ., Evanston, Ill.); L. Grimellini, T. Kikuchi, L. Lendinara, and L. Monari (Bologna. Università). [nd]. Contract [AT(11-1)-89]. 7p.

The lifetime of the Λ^0 hyperon was measured in a helium bubble chamber. A beam of mesons (K^-) produced low-momentum Λ^0 hyperons in the chamber. A sample of ~1800 Λ^0 hyperons was measured and analyzed. A value of $2.35 \pm 0.10 \times 10^{-10}$ sec was obtained for the lifetime. (M.C.G.)

717 (TID-16986) THE RADIATION OF GRAVITATIONAL WAVES RESULTING FROM THE EMISSION AND ABSORPTION OF ELECTROMAGNETIC WAVES. Peter J. Westervelt (Brown Univ., Providence). Sept. 17, 1962. Contract AT(30-1)-2262. 16p.

The gravitational field in the radiation zone generated by the emission and absorption of an ideally collimated modulated plane polarized electromagnetic wave is obtained. The flux of gravitational energy and the total gravitational power are calculated for this process and the latter turns out to be independent of the modulation frequency, provided the source and emitter are separated by several gravitational wavelengths. (auth)

718 (TID-17014) SCATTERING OF GAMMAS THROUGH DUCTS. Interim Report. Chan M. Park, Chaitanya B. Agnihotri, and Joseph Silverman (Maryland. Univ., College Park). June 1, 1962. Contract AT(40-1)-2845. 59p. (UMNE-2)

An area-wise dose rate calculation method using differential angular dose albedos is presented for application in radiation shielding design. A FORTRAN program employing differential dose albedos was set up to calculate the dose rate resulting from singly reflected photons in a straight rectangular duct and an L-shaped two-legged rectangular duct. A sample calculation is included. (J.R.D.)

719 (UCRL-9599) DOUBLE MESON PRODUCTION IN PROTON-DEUTERON COLLISIONS. [PART] II. Norman E. Booth, Alexander Abashian, and Kenneth M. Crowe (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1961. Contract W-7405-eng-48. 16p.

The He^3 and H^3 spectra resulting from collisions of 740-Mev protons with deuterium were measured. Results are shown in figures and tables. The anomalous bump found previously in the He^3 spectra and assumed to correspond to double pion production was clearly evident. It was con-

cluded that the anomaly must be assigned an isotopic spin I = 0. (M.C.G.)

720 (UCRL-10217) CALCULATION OF REGGE TRAJECTORIES BY USING DISPERSION RELATIONS. Philip G. Burke and Cecil Tate (California. Univ., Berkeley. Lawrence Radiation Lab.). May 24, 1962. Contract W-7405-eng-48. 11p.

Results of an evaluation of the position of a Regge pole which lies farthest to the right in the complex angular-momentum plane, l, are presented for scattering amplitude and trajectory determinations. It is believed that the use of the elastic unitarity condition together with a cutoff procedure may be capable of giving reasonably accurate trajectories in the full pion-pion problem. (J.R.D.)

721 (UCRL-10236) Ξ^- HYPERONS IN THE REACTION $K^- + p \rightarrow \Xi^- + K^+$. Luis W. Alvarez, J. Peter Berge, George R. Kalbfleisch, Janice Button-Shafer, Frank T. Solmitz, M. Lynn Stevenson, and Harold K. Ticho (California. Univ., Berkeley. Lawrence Radiation Lab.). June 5, 1962. Contract W-7405-eng-48. 14p.

The reaction $K^- + p \rightarrow \Xi^- + K^+$ is being studied in a 72-in. hydrogen bubble chamber. About 450 events were analyzed in which the Ξ^- decayed into $\Lambda + \pi^-$ and the Λ subsequently decayed into $p \rightarrow \pi^-$. In the momentum range from 1.2 to 1.6 Bev/c incident K^- momentum, the cross section rose from 60 to 200 μb. The decay distributions showed a substantial amount of parity violation, indicating the presence of both s- and p-wave amplitudes in the Ξ^- decay. The s-wave seemed to dominate over the p-wave. The angular distributions were characterized by marked forward peaking of the Ξ^-. (M.C.G.)

722 (SCL-T-443) CONCERNING A POSSIBLE WAY OF ELECTRON BONDING ON CRYSTAL SURFACES. Ig. Tamm. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.) from Physik. Z. Sowjetunion, 1: 733-46(1932). 13p.

Under certain circumstances an electron can be bound at the interface of a periodic potential lattice (crystal), first, when its energy W falls onto a "forbidden band" of the energy spectrum in the infinitely extended potential lattice, and, secondly, whenever the energy W is smaller than the potential energy U_0 in the surrounding outside space of the environment. The eigenfunction Ψ of such a surface state decreases exponentially on either side of the interface. A simple one-dimensional example (the lattice model of Kronig and Penney) was calculated, and the discrete spectrum of the surface states was determined. The possible significance of these electron states concerning the question of the nature of the potential threshold barrier at a crystal surface, whereby those electron states may also be important for the understanding of the contrast occurring in dielectric crystals between the "free" mobility of the photoelectrons in the crystal interior and the bonding of the electrons which enter the crystal from the outside through its surface is discussed. (auth)

723 A GROUP THEORETICAL MODEL FOR STRONG INTERACTION DYNAMICS. Pekka Tarjanne (NORDITA, Copenhagen). Ann. Acad. Sci. Fennicae, Ser. A, VI, No. 105, 1-94(1962). (In English)

A dynamical model for strong interactions is presented. This model, based on a generalization of an approach to meson-nucleon scattering, enables definite quantitative calculations to be made concerning forces between different types of particles and resonances, in the framework of several suggested group theoretical schemes. The baryonic resonances are treated as composite systems of baryons and pseudoscalar mesons (or vector mesons). The formalism is then used to classify the resonances into multiplets associated with representations of groups of rank two. In addition, tables of scattering amplitudes and generalized Clebsch-Gordan coefficients for use in decay mode and width calculations are presented. Using different groups as a basis for the higher symmetry laws going beyond isotopic spin and hypercharge gauges, definite physical predictions are made and experiments to be performed in order to make a choice between the schemes are suggested. (auth)

724 P-WAVE NEUTRON STRENGTH FUNCTION. Harry Fiedeldey and Wilhelm E. Frahn (Univ. of Stellenbosch, Cape Province, South Africa). Ann. Phys. (N. Y.), 19: 428-47(Sept. 1962).

Explicit expressions for the P-wave neutron strength function $\Gamma_n^{(1)}/D$ are derived from a complex optical model potential consisting of a rounded real potential well, an imaginary part describing both volume and surface absorption, and a real spin-orbit term. Comparison with experimental data on $\Gamma_n^{(1)}/D$ permits, among other things, the strength of spin-orbit coupling in the intermediate energy region to be estimated. (auth)

725 SPECTRAL REPRESENTATION OF THE MANY-TIME, CAUSAL GREEN'S FUNCTION IN NONRELATIVISTIC MANY-BODY THEORY. Donald H. Kobe (Univ. of Minnesota, Minneapolis). Ann. Phys. (N. Y.), 19: 448-57(Sept. 1962).

The exact spectral representation of the many-time, causal Green's function, which is the ground-state average of the time-ordered product of creation and annihilation operators in the Heisenberg picture, is obtained by taking the time Fourier transform of the function. This spectral representation shows that the function has poles at the excitation energies, and residues that are related to the state amplitudes. The usual two-time Green's function can be written in terms of the many-time Green's function, and the two-time spectral representation may be obtained from the many-time spectral representation by a process of integration. The two-time spectral representation obtained in this manner agrees with the one obtained directly, but the derivation gives some insight into the relation between the two spectral representations. (auth)

726 EFFECTIVE RANGE THEORY AND THE LOW ENERGY HYPERON-NUCLEON INTERACTIONS. J. J. de Swart (Univ. of Chicago) and C. Dullemond. Ann. Phys. (N. Y.), 19: 458-95(Sept. 1962). (EFINS-62-15)

The effective-range theory is treated in the case of coupled channels, with allowance made for channels with higher l-waves. It is shown how to take the Coulomb interaction into account. A shape-independent relation connecting the volume integral of the potential and the scattering length is derived. Applying this relation to the light hyperfragments leads to the estimates of the Λ-nucleon scattering lengths. The low energy Σ^--proton reactions are considered. It is shown how account can be taken of the kinematical effects arising from the mass differences between the members of the same isomultiplet. The effective-range parameters are calculated for three different potentials corresponding to global and antiglobal symmetry. These parameters are applied to the Σ^--proton reactions. It is shown that the global symmetry assumption is consistent with the Λ-nucleon scattering lengths, the ratio $\Sigma^0/(\Sigma^0 + \Lambda^0)$ obtained in the Σ^--proton reactions, and the data on K^- absorption in the deuterium. Also it is shown that these data rule out the antiglobal symmetry assumption. (auth)

727 THE AUTORESONANCE MOTION OF A PARTICLE IN A PLANE ELECTROMAGNETIC WAVE. A. A. Kolomenskii and A. N. Lebedev (Lebedev Inst. of Physics, Moscow). Doklady Akad. Nauk SSSR, 145: 1259-61(Aug. 21, 1962). (In Russian)

In a magnetic field there is a possibility of resonance interaction between the field of a plane wave and a particle, such that the energy of the particle continually increases. In principle, the resonance can occur at any value of the wave frequency ω and of the hydromagnetic frequency $\omega_\beta = eB_0/mc\,\gamma$. In this process the resonance will be maintained automatically, in spite of the increase in energy (and in mass) of the particle, and the corresponding decrease in the frequency ω_β. This phenomenon is called an autoresonance between the wave and the particle. The equation of motion of the particle is written in terms of the transverse electric field, a longitudinal force due to the transverse motion of the particle and the magnetic field, and a force imposed by the external magnetic field B_0. The following relationship was derived: $\gamma[1 - (\vec{\beta}\vec{n}/\omega)] = \text{const} = \gamma_0(1 - \beta_0)$. Here γ_0 is the total initial energy, and β_0 is the initial velocity component of the particle in the direction $\underline{k}$. The equations show that a particle injected into a plane wave under resonance conditions moves in a spiral with an increasing radius and pitch, and the energy of the particle increases on the average. (TTT)

728 A POSSIBLE DETERMINATION OF ADDITIONAL CHARACTERISTICS OF AN UNSTABLE PARTICLE. A. M. Perelomov. Dokl. Akad. Nauk SSSR, 146: 75-8(Sept. 1, 1962). (In Russian)

The difficulties in describing a theory of unstable particles disappear to a significant extent, if it is assumed stable particles exist at the beginning and end of a process, and that an unstable particle only describes the resonances in the processes of scattering and of particle conversion (the decay of a particle does not depend on its mode of formation in a number of cases). In addition to the mass and lifetime of an unstable particle, it is also possible to "determine" other characteristics such as the magnetic dipole moment and the electrical dipole moment of the unstable particle. Spin reversal can take place in a transmitted particle. The scattering of a neutral stable particle through an intermediate state can result in a spin reversal of the particle, but the average reversal with time is equal to zero. The theory is invariant with respect to time inversion, but it does not conserve spacial parity. The spin reversal corresponds to the concept of an electrical dipole moment of an unstable state. If a particle $\underline{b}$ before scattering is polarized along the $\underline{z}$ axis, and the electrical field is directed along the $\underline{x}$ axis, it is expected that after scattering the polarization of the particle is reversed in the xy plane by an angle θ. A formula was derived that corresponds to the dipole moment of an exponentially decaying particle. The dipole moment is proportional to the derivative of the wave function with respect to time. At the beginning of the scattering process, when the amplitude of the wave function is increasing, the dipole moment has a definite sign, and the spin reversal takes place in a definite direction. At the end of the scattering process, the amplitude of the unstable particle is decreasing, and the dipole moment has a different sign with spin reversal taking place in the opposite direction. The average spin reversal with time is equal to zero. (TTT)

729 MEASUREMENT OF THE POLARIZATION OF NEUTRONS FROM THE (d,T) REACTION WITH POLARIZED DEUTERONS. F. Seiler, E. Baumgartner, W. Haeberli, P. Huber, and H. R. Striebel (Universität Basel). Helv. Phys. Acta, 35: 385-402(1962). (In German)

The polarization of (d,T) neutrons produced by 170-kev deuterons from the Basel polarized-deuteron source was measured using helium as an analyzer. The transverse polarization of neutrons emitted at 90° with respect to the incident deuteron beam was found to be $P_1^n = 0.260 \pm 0.036$. The direction of the neutron polarization is opposite to the vector polarization of the deuterons, in agreement with the theory of the (d,T) reaction. From this measurement and from the measured anisotropy of the neutrons, all elements of the polarization vector and tensor of the deuterons produced by the source can be determined, if certain well-founded assumptions are made about the properties of the source and of the (d,T) reaction. The results are in reasonable agreement with the expected behavior of the source. (auth)

730 NUCLEON-NUCLEON INTERACTIONS AT LOW ENERGIES. A. Houriet and C. A. Héritier (Universität Freiburg i. B.). Helv. Phys. Acta, 35: 414-24(1962). (In French)

The nucleon-nucleon interactions were studied in order to determine the influence of the primary pion-nucleon resonance. The characteristic constants were calculated relative to the experimental values. The renormalized coupling constant was found to be located in the same region as the pion-nucleon diffusion. (tr-auth)

731 THE RELATION BETWEEN THE OPTICAL MODEL AND THE DIRECT INTERACTION THEORY OF INELASTIC SCATTERING. W. R. Gibbs (Université de Neuchâtel, Switzerland). Helv. Phys. Acta, 35: 437-50 (1962). (In English)

Using Feshbach's unified theory of nuclear reactions the contribution to the optical potential due to the loss of particles through direct interaction inelastic scattering was calculated. The imaginary part was found to be consistent with the magnitude required to fit elastic scattering data. A relation connecting V, R, and a was derived and checked against some existing optical model results. This relation allows a shape parameter to be determined for the nucleon-nucleon potential and may be used to reduce the number of free parameters in optical model calculations. (auth)

732 EFFECT OF COMPTON SCATTERINGS BY AIR MOLECULES ON THE SHARPNESS OF A BEAM OF GAMMA RAYS. Lawrence Baylor Robinson (Univ. of California, Los Angeles). J. Appl. Phys., 33: 2315-18(July 1962).

The passage of a beam of gamma rays through air is examined. The effect of Compton scatterings on the sharpness of the gamma beam is discussed. Interest is focused on the component of the beam that suffers little energy loss. The problem is similar, in some respects, to multiple scattering of electrons with negligible energy loss. The mathematical expression for the collision process, however, is different. The cross section for Compton scatterings is introduced in order to obtain scattering probabilities. Some numerical results are obtained that can be applied to cobalt-60 gamma rays. The results are presented in graphical form. (auth)

733 POSITRONIUM LIFETIME IN CONDENSED HYDROGEN. D. C. Liu and W. K. Roberts (National Aeronautics and Space Administration, Cleveland). Phys. and Chem. Solids, 23: 1337-40(Sept. 1962).

The orthopositronium lifetime τ_2 in gaseous, liquid, and solid hydrogen was measured. τ_2 is 31.2 ± 1.5 nsec for

liquid at normal temperature of ebullition and is 16.3 ± 0.8 nsec for solid below the melting point. There is a sharp rise in τ_2 at melting, but the abundance of the orthopositronium component I_2 remains the same. For gaseous hydrogen at densities corresponding to the liquid and solid densities, τ_2 is density-dependent and shows no rapid change in the density range of the solid-to-liquid phase transition. These results lead to the conclusion that the orthopositronium lifetime or its pickoff rate is influenced by the physical state of the condensed hydrogen. (auth)

734 HARMONICS IN THE SCATTERING OF LIGHT BY FREE ELECTRONS. Vachaspati (Univ. of Lucknow, India). Phys. Rev., 128: 664-6(Oct. 15, 1962).

The presence of harmonics in the scattering of light by free electrons is pointed out. The cross section for the second harmonic is proportional to the energy flux and to the square of the wavelength of the incident light. Thus experiments in which intense monochromatic microwave beams are scattered by plasmas are the most promising for the detection of the effect. (auth)

735 d-He^4 ELASTIC SCATTERING FROM 6 TO 14 Mev. Leona Stewart, J. E. Brolley, Jr., and L. Rosen (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 128: 707-11(Oct. 15, 1962). (LADC-5181)

Elastic differential cross sections for d-He^4 scattering have been measured for deuteron laboratory energies between 6 and 14 Mev. Both deuterons and alpha particles were accelerated in the Los Alamos variable-energy cyclotron and focused at the center of the Los Alamos multiplate camera. The charged-reaction products were identified on the basis of range measurements in processed K2 emulsions. The present results are at variance with previous work at 8 Mev and also indicate significant deviations at large angles from earlier experiments at 13.7 Mev. Around 10 Mev, previous results have been substantiated. (auth)

736 DISTORTED-WAVES THEORY OF DOUBLE-EXCITATION BY INELASTIC SCATTERING. N. Austern (Univ. of Pittsburgh and Univ. of Copenhagen), R. M. Drisko, E. Rost, and G. R. Satchler. Phys. Rev., 128: 733-40(Oct. 15, 1962).

It is shown how the distorted-waves theory of inelastic scattering can give rise to angular distributions with "anomalous phase," such as observed in recent experiments with alpha particles. These occur when the scattering takes place through second-order effects; excitation of a two-phonon vibrational state is studied explicitly. There is an important cancellation between the amplitude for simultaneous excitation and part of that for successive excitation, without which the anomalous phase would not be observed. These conclusions are contrasted with the predictions of a theory using plane-wave Born approximation. Further study of the cancellation is suggested as a sensitive test of the optical model. (auth)

737 POLARIZATION AND DIFFERENTIAL CROSS SECTIONS IN n-d SCATTERING. A. J. Elwyn, R. O. Lane, and A. Langsdorf, Jr. (Argonne National Lab., Ill.). Phys. Rev., 128: 779-89(Oct. 15, 1962). (TID-16265)

The polarization and differential cross section for neutrons scattered from deuterium are measured at five laboratory angles (22°, 48°, 80°, 100°, and 150°) for incident neutron energies of 0.5, 1.0, and 1.95 Mev. The neutrons were produced in the $Li^7(p,n)Be^7$ reaction. The partially polarized beam emitted at 51° was used first directly and then with the spins processed through 180° in the transverse field of an electromagnet in order to determine the asymmetry in the intensities after scattering from deuterium. The results at 0.5 and 1.0 Mev give zero polarization within 2-3%. At 1.95 Mev small positive polarizations up to 4% are observed. The differential cross sections measured are more peaked at large angles than in earlier work. These data are compared with earlier calculations and a new phase-shift analysis of these measurements is made. (auth)

738 DEUTERON MAGNETIC DIPOLE DISINTEGRATION BY 180° ELECTRON SCATTERING. G. A. Peterson and W. C. Barber (Stanford Univ., Calif.). Phys. Rev., 128: 812-20(Oct. 15, 1962).

The magnetic dipole disintegration of the deuteron has been measured for excitation energies up to 16 Mev in the presence of relatively small electric multipole contributions by using a method of inelastic electron scattering at 180°. Electrons of initial energy 41.5 Mev were magnetically deflected before and after scattering so that those scattered at 180° entered a magnetic spectrometer set at 160° with respect to the incident beam. The experimental cross sections measured relative to elastic scattering from the proton are higher than predicted by the electrodisintegration theory of Jankus. The discrepancy may be an indication of mesonic exchange currents which are not included in the Jankus theory. (auth)

739 PHASE PARAMETER REPRESENTATION OF PROTON-PROTON SCATTERING FROM 9.7 TO 345 Mev. [PART] II. G. Breit, M. H. Hull, Jr., K. E. Lassila, K. D. Pyatt, Jr., and H. M. Ruppel (Yale Univ., New Haven). Phys. Rev., 128: 826-30(Oct. 15, 1962). (TID-16178)

Phase parameters for fits YLAM and YRB1 to p-p scattering data are presented in the form of graphs suitable for quantitative application. (Additional tabulated material is available from the American Documentation Institute.) Modifications in YLAM arising from the use of a potential are recorded with special attention to the lower energies. Modifications in fit YLAM suggested by newer polarization data are described. Evidence from p-p data regarding the spin-orbit component of the interaction is compared with that from n-p data in the context of the question of validity of charge independence for this component. (auth)

740 PHASE-PARAMETER REPRESENTATION OF NEUTRON-PROTON SCATTERING FROM 13.7 TO 350 Mev. [PART] II. M. H. Hull, Jr., K. E. Lassila, H. M. Ruppel, F. A. McDonald, and G. Breit (Yale Univ., New Haven). Phys. Rev., 128: 830-2(Oct. 15, 1962).

Phase parameters for fits YLAN3M and YLAN1 to n-p scattering data are presented in the form of graphs suitable for quantitative application. (Additional tabulated material is available from the American Documentation Institute.) Modifications in YLAN3M arising from the use of a potential are recorded with special attention to lower energies. (auth)

741 PION RESONANCES. Fredrik Zachariasen (California Inst. of Tech., Pasadena) and Charles Zemach. Phys. Rev., 128: 849-58(Oct. 15, 1962).

A self-consistent calculation of some features of the low-energy pion resonances is performed by a "bootstrap" method which preserves unitarity and the analytic properties of scattering amplitudes and satisfies crossing symmetry approximately. The interaction of two-pion states with pion-omega meson states is decisive for the properties of the ρ meson. Values of the ρ-meson mass and width and the ω-meson width are obtained in terms of the pion and ω-meson masses and are in fair agreement with experiment. (auth)

742 PION-PION SCATTERING INCLUDING INELASTIC INTERMEDIATE STATES. B. H. Bransden (The Uni-

versity, Glasgow), I. R. Gatland, and J. W. Moffat. Phys. Rev., 128: 859-62(Oct. 15, 1962).

The inverse amplitude dispersion relations for pion-pion scattering including inelastic intermediate states are solved for given models of the inelastic cross section. These models are calculated by representing the four-pion intermediate state as the combination of a three-pion resonance and a single pion. Interesting results are obtained using a small and slowly varying inelastic cross section, since this leads to a resonant behavior of $R = \sigma^{tot}/\sigma^{el}$ when the real part of the P-wave phase shift passes through π in the inelastic region. The original solution of the pure elastic inverse amplitude equations exhibits a single sharp resonance in the P wave, and the inclusion of a resonant R in the iteration scheme results in the appearance of a second P-wave resonance. When the pion-pion coupling constant $\lambda \cong -0.1$ and the three-pion decay coupling constant $G^2 \cong 1$, the positions and widths of the two di-pion resonances are $M_\zeta \cong 600$ Mev, $\Gamma_\zeta \cong 30$ Mev, $M_\rho \cong 800$ Mev, and $\Gamma_\rho \cong 50$ Mev. This value of λ gives S waves in good agreement with independent analyses of π-N scattering data. These results prove that, at least for pion-pion scattering, solutions exist possessing two resonances with the same quantum numbers. When a rapidly rising inelastic cross section is used corresponding to a large G^2, the original elastic solution exhibiting a single P-wave resonance is changed inappreciably due to the dominance of the "near-by" inverse amplitude left cut. (auth)

743 SOFT PION EMISSION INDUCED BY ELECTROMAGNETIC AND WEAK INTERACTIONS. Y. Nambu and E. Shrauner (Univ. of Chicago). Phys. Rev., 128: 862-8(Oct. 15, 1962).

Some extensions are considered for the relation obtained by Nambu and Lurié between an elastic process and the accompanying soft pion emission process under the assumption of approximate γ_5 invariance. In particular, a generalized formula is found which enables one to describe the electropion production $e + N \rightarrow N + e + \pi$ and the neutrino-pion production $\nu + N \rightarrow N + e + \pi$ at the threshold of Nπ system in terms of the vector (Hofstadter) and the axial-vector form factors. Explicit forms of the cross sections are given. (auth)

744 THEORY OF CHARGED VECTOR MESONS INTERACTING WITH THE ELECTROMAGNETIC FIELD. T. D. Lee and C. N. Yang (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 128: 885-98(Oct. 15, 1962).

It is shown that starting from the usual canonical formalism for the electromagnetic interaction of a charged vector meson with arbitrary magnetic moment one is led to a set of rules for Feynman diagrams, which appears to contain terms that are both infinite and noncovariant. These difficulties, however, can be circumvented by introducing a ξ-limiting process which depends on a dimensionless positive parameter $\xi \rightarrow 0$. Furthermore, by using the mathematical artifice of a negative metric the theory becomes renormalizable (for $\xi > 0$). (auth)

745 APPLICATION OF ξ-LIMITING PROCESS TO INTERMEDIATE BOSONS. T. D. Lee (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 128: 899-910 (Oct. 15, 1962).

The ξ-limiting process discussed in the preceding paper is used to study the electromagnetic properties of the intermediate boson $W^\pm$. Assuming that the limit $\xi \rightarrow 0$ exists, it is found that, by a rearrangement of the perturbation series, the radiative correction to the quadrupole moment of $W^\pm$ can be calculated and is proportional to $\alpha \ln\alpha$. Similar radiative corrections to the leptonic decay modes of $W^\pm$, μ decay, and the β decay of a "bare" nucleon are also discussed. (auth)

746 INFLUENCE OF CORRELATIONS ON THE DIELECTRIC BEHAVIOR OF AN ELECTRON GAS. NON-PERTURBATIVE APPROACH TO THE MANY-FERMION SYSTEM. Oldwig von Roos (California Inst. of Tech., Pasadena). Phys. Rev., 128: 911-18(Oct. 15, 1962).

Starting with the equation of motion for the density matrix operator of an electron gas in second quantization, a system of matrix equations is derived for matrix elements connecting states with various numbers of electron-hole pairs. Allowing up to n electron-hole pairs and neglecting all states with more than n pairs yields a set of $(n + 1)^2$ coupled equations for the various amplitudes in close analogy to the nth order Tamm-Dancoff approximation. The starting point of this approximation, in which all matrix elements connecting the Fermi vacuum with any pair states are neglected (zero-order Tamm-Dancoff approximation), is an equation for the self-consistent field rather than for free particles as in the usual Tamm-Dancoff method. Correlation effects are therefore automatically taken into account when pair states are included. In a certain sense the approximation scheme given here can be thought of as being an expansion in the deviation of the Fermi surface from the sharp edge of the free-particle ground state, the deviation being caused by the Coulomb interaction among the particles. In this paper, calculations based on the first Tamm-Dancoff approximation (taking into account only one electron-hole pair) are presented. An expression for the dielectric constant will be derived and applied to a determination of the effects of correlations on the wavelength dependence of plasma oscillations. The theory will be compared with the experiments by Watanabe on the energy loss of fast electrons in metal foils and it will be seen that the agreement with experiment is good considering the inherent simplicity of the theory. (auth)

747 STATIC APPROXIMATION AND BOUNDS ON SINGLE-CHANNEL PHASE SHIFTS. Yukap Hahn, Thomas F. O'Malley, and Larry Spruch (New York Univ. New York). Phys. Rev., 128: 932-42(Oct. 15, 1962).

A single-channel scattering process with the set of quantum numbers C is completely characterized by a phase shift, ηC. A common approximation in the determination of ηC for the scattering of a particle by a compound system is to assume that, apart from the possibility of an exchange of the incident particle with an identical target particle, the target is unaffected by the incident particle. The incident particle is then scattered by the static potential generated by the target in its ground state. The phase shift determined in this approximation, to be called ηC^P, can be calculated for a number of scattering processes. Let H represent the Hamiltonian of the entire system, incident particle plus target, let E_{T0} be the ground-state energy of the target, and let $E'C^Q$ be the smallest energy for which $E'C^Q + E_{T0} - H$ is a negative definite operator in the space in which the given quantum numbers are C and in which the ground state of the target is projected out. Utilizing the generalized optical potential formalism due to Feshbach and others, it can then be shown that $\eta C > \eta C^P$ if the incident energy is less than $E'C^Q$. (The bound is probably valid for higher energies, perhaps for all energies for which the process remains a single-channel process. If so, however, the difference between ηC and ηC^P for these higher energies will generally be large, of the order of a multiple of π, and the bound will not be immediately useful. We will, therefore, be concerned primarily with incident energies E' less than $E'C^Q$.) Furthermore, as one allows

for more and more virtual excitation of the target system, the approximate phase shift is guaranteed to improve if E′ is less than E′C♀, and E′C♀ will itself increase. Applications are given to the scattering of electrons and of positrons by hydrogen atoms. (auth)

748 THEORY OF THE FERMION LIQUID. Fa Yueh Wu and Eugene Feenberg (Washington Univ., St. Louis). Phys. Rev., 128: 943-55(Oct. 15, 1962).

The ground-state wave function generated by a system of interacting bosons is used as the correlation factor in a trial function describing the interacting fermion system. Expectation values are computed by the technique of the generalized normalization integral. The resulting cluster integrals are evaluated by introducing simple approximate forms for the n-particle distribution functions defined by the boson wave function. To illustrate the method, it is applied to establish a connection between known results for fermion and boson forms of a hard-sphere system at low density. As a second illustration experimental information on liquid He^4 is used to work out properties of a hypothetical fermion-type system of mass 4. Results are given for the energy, effective mass, and magnetic behavior. The application to He^3 waits on the evaluation of the radial distribution function and liquid structure factor for the corresponding artificial boson system of mass 3. (auth)

749 STATISTICAL MECHANICS OF A NONIDEAL BOSON GAS: PAIR HAMILTONIAN MODEL. Marshall Luban (Univ. of Chicago). Phys. Rev., 128: 965-87(Oct. 15, 1962).

This work is concerned with a microscopic model of a nonideal boson gas. The Hamiltonian is treated in a rigorous manner free of all approximations and, in particular, the Bogoliubov approximation of replacing the zero-momentum single-particle creation and destruction operators by a c number is entirely avoided. Utilizing a method due to Wentzel, the Hamiltonian is replaced by one involving products of two second quantized operators which, in general, can be diagonalized. This replacement is shown to be rigorously valid in the infinite volume limit for all temperatures despite the avoidance of the Bogoliubov approximation. It is found that the assumption of a positive-definite quasiparticle excitation spectrum $\epsilon(k)$ becomes untenable for temperatures T less than a critical value T_c, if the interparticle potential is described by a certain kernel which possesses positive eigenvalues only, corresponding to a sufficiently repulsive interparticle force. Assuming that $\epsilon(k) = 0$ only for $k = 0$, it is found that for $T < T_c$ the system undergoes an Einstein condensation into the $k = 0$ single-particle state, and the integral equations characterizing the system are precisely the same as would be obtained if the Bogoliubov approximation were made, proving within the framework of this model the strict validity of this approximation procedure. The well-known criterion for an Einstein condensation $v(0) > 0$, where $v(k)$ is the Fourier transform of the interparticle potential, is shown to be a weaker statement of our eigenvalue criterion. Further, in agreement with Girardeau and Arnowitt, it is found that an energy gap separates $\epsilon(0)$ and $\epsilon(k)$ for $k > 0$. An approximation method is developed for solving the integral equations which describe those systems which undergo an Einstein condensation, and it is shown that this method can be justified if $|T - T_c| \lesssim T_c/10$, and in cases of short-range repulsive interparticle forces and systems for which $\rho v(0)$ possesses a certain prescribed upper bound, ρ being the number of particles per unit volume. The transition temperature is found to be lower than the corresponding quantity for the ideal boson gas of the same density. A detailed discussion of the thermal properties of the system in the vicinity of T_c is also given. In an Appendix a general type of smeared Einstein condensation is assumed, and it is found that for systems in which this property occurs $\epsilon(k)$ is linear for small k. This ansatz is shown to be tenable only if $v(0) < 0$. Finally, by assuming an appropriate pseudopotential representation of a hard repulsive core and by including a weak, long-ranged attractive force between particles, $\epsilon(k)$ shows a nonmonotonic behavior of the same qualitative type as observed in liquid He^4. (auth)

750 SYMMETRY MODEL FOR THE NEW RESONANCES. R. F. Sawyer (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 128: 988-?(Oct. 15, 1962).

A global symmetry is proposed which produces what seems to be a sensible classification of boson resonances and of N*, Y* resonances. A novel feature is the prediction that the cascade particle be spin $\frac{3}{2}$. (auth)

751 ADAIR SPIN ANALYSIS WITH PARITY NONCONSERVATION. S. B. Treiman (Princeton Univ., N. J.). Phys. Rev., 128: 1342(Nov. 1, 1962).

A variation of the Adair spin analysis is considered for an unstable boson produced in association with a hyperon whose decay violates parity conservation. (auth)

752 IMPULSE APPROXIMATION CALCULATION OF HIGH-ENERGY DEUTERON-DEUTERON ELASTIC SCATTERING. Arnold Tubis and Bernard Chern (Purdue Univ., Lafayette, Ind.). Phys. Rev., 128: 1352-6(Nov. 1, 1962).

The high-energy deuteron-deuteron elastic scattering cross section and vector polarization has been calculated on the basis of the impulse approximation with the neglect of off-energy-shell effects in the nucleon-nucleon scattering matrix and effects of multiple scattering. The results are in terms of the free nucleon-nucleon scattering amplitudes and an appropriate Fourier transform of the deuteron wave function. For simplicity the D-state component of the deuteron has been neglected throughout this calculation. Numerical results are given for 312 and 620 Mev. At the two energies considered, the results for the cross section are comparable to those for nucleon-deuteron scattering. The validity of the approximations used and possible improvements of the calculation are discussed. (auth)

753 DEUTERON COMPTON EFFECT. R. S. Jones, H. J. Gerber, A. O. Hanson, and A. Wattenberg (Univ. of Illinois, Urbana). Phys. Rev., 128: 1357-64(Nov. 1, 1962).

Elastic scattering by deuterons of photons between 190 and 250 Mev has been measured by exposing a liquid deuterium target to the bremsstrahlung beam of the University of Illinois 300-Mev betatron. The scattered photons are detected by a lead glass total absorption-type Cherenkov counter, and the recoil deuterons were momentum analyzed in a magnetic field and detected by a scintillation counter telescope. The observed cross sections in the center-of-momentum system, in Thomson proton units of $(e^2/M_p)^2 = 2.35 \times 10^{-32}$ cm^2/sr, are, for a photon c.m. scattering angle of 140°, 0.879 ± 0.10 at 189 Mev and 0.751 ± 0.11 at 219 Mev; and for a photon c.m. scattering angle of 110°, 0.943 ± 0.13 at 218 Mev and 1.47 ± 0.26 at 250 Mev. These values are compared with those using the neutron and proton amplitudes predicted by dispersion relations and employing the impulse approximation, and with the exception of the point at 189 Mev are found to be consistent with the theoretical calculations. (auth)

754 SINGULARITIES IN ANGULAR MOMENTUM OF THE SCATTERING AMPLITUDE FOR A CLASS OF SOLUBLE POTENTIALS. A. O. Barut and F. Calogero (Univ. of California, Berkeley). Phys. Rev., 128: 1383-93(Nov. 1, 1962).

The analyticity of the scattering amplitude in the varia-

bles, energy, and angular momentum is explicitly studied for square well and a class of continuous potentials having a $1/r^2$ type of core or tail. The trajectories of the poles in the l plane and their residues have been determined numerically. (auth)

755 DECAY OF HEAVY BOSONS. E. M. Henley and B. A. Jacobsohn (Univ. of Washington, Seattle). Phys. Rev., 128: 1394-1401(Nov. 1, 1962). (TID-16067)

The properties of the decays of all heavy bosons of zero strangeness, angular momenta ≤2, and isospin ≤1 are analyzed. First, we describe the symmetry characteristics of N-pion states (for N ≤ 5) with respect to permutations in isospin and momentum space. Secondly, we give the strong, first-order (with emission of a real photon), and second-order electromagnetic decays together with the nonrelativistic and extreme relativistic barrier factors for each initial spin, parity, and G parity. These barrier effects (together with the amount of phase space available) are important in determining relative decay rates. Finally, we present the matrix elements for strong and electromagnetic decays into 4 or fewer pions. All results are summarized in tabular form. (auth)

756 QUASI-CLASSICAL THEORY OF A RELATIVISTIC SPINNING ELECTRON. Ralph Schiller (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev., 128: 1402-12 (Nov. 1, 1962).

The quasi-classical spin theory is a modified Hamilton-Jacobi theory for a classical relativistic dipole whose space-time trajectory is coupled to its spin motion. The equations of this quasi-classical theory are almost identical with the second-order (squared) Dirac equation, and, in fact, form a new WKB approximation to the second-order Dirac equation. We quantize this theory by requiring that a classical spinor "wave function" be continuous and single valued, and that it satisfy an eigenvalue equation. We find for a particle in a uniform magnetic field, and in a Coulomb field, that this quasi-classical theory predicts the same energy and angular momentum eigenvalues as the Dirac theory. The quasi-classical theory is invariant under Lorentz transformation, spin rotations, and charge conjugation. The spinor wave functions are form invariant with respect to arbitrary canonical transformations. (auth)

757 DESCRIPTION OF PARTICLES IN QUANTIZED FIELD THEORY. P. J. Peebles (Princeton Univ., N. J.). Phys. Rev., 128: 1412-18(Nov. 1, 1962).

The problem of establishing the connection between quantized field theory and observations is discussed in a nonrigorous way without recourse to the idea of asymptotic free fields. The method is based on a prescription for the state vector associated with a single physical particle using the interacting field operator. It is shown that the method leads to the usual form for the scattering matrix, obtained via the asymptotic condition. As a second application, the problem of describing an unstable particle is discussed briefly. (auth)

758 BEHAVIOR OF REGGE POLES IN A POTENTIAL AT LARGE ENERGY. H. A. Bethe and T. Kinoshita (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 128: 1418-24 (Nov. 1, 1962).

Following Mandelstam's suggestion, a potential which can be expanded in a power series in r, beginning with $1/r$, is considered. Then at large energy (positive or negative) there will be Regge Poles at all negative integral values of l. If the $1/r$ term is absent in the expansion of the potential, the pole at $l = -1$ will be absent. Generally, if r^{2n-1} is the first nonvanishing odd power term in the potential expansion, the poles at $-1, -2, \cdots, -n$ are absent. If the potential expansion contains only even non-negative powers of r, there will be no Regge poles at finite negative l in the limit of large energy. If the potential behaves as $-a/r^2$ at small r, the scattering amplitude has a cut in the l plane from $-\frac{1}{2}-a^{\frac{1}{2}}$ to $-\frac{1}{2}+a^{\frac{1}{2}}$, and the Regge poles are no longer located at negative integers at large energy. For finite energy, it is shown that a pole at a positive integer or half-integer l implies another pole at $-l-1$ but that the residues at these poles are, in general, different from each other. (auth)

759 RADIATIVE CORRECTIONS TO THE TOTAL CROSS SECTION FOR ANNIHILATION OF A PAIR INTO PHOTONS. G. Andreassi (Università, Trieste, Italy and Istituto Nazionale di Fisica Nucleare, Trieste, Italy), G. Calucci, G. Furlan, G. Peressutti, and P. Gazzola. Phys. Rev., 128: 1425-36(Nov. 1, 1962).

The total cross section to e^6 is calculated for annihilation of an electron-positron pair into photons. Comparison with experiments at CERN is discussed and some consideration about the behavior of cross section for electrodynamical processes at high energy is outlined. Some details of calculation are sketched in an appendix. (auth)

760 RADIATIVE CORRECTIONS TO DECAY PROCESSES MEDIATED BY VECTOR BOSONS. R. A. Shaffer (Johns Hopkins Univ., Baltimore). Phys. Rev., 128: 1452-7(Nov. 1, 1962).

The lowest order electromagnetic corrections to β and μ decay have been calculated in an intermediate vector-boson theory. Assuming universal coupling, the μ lifetime agrees with the experimental value if the boson's mass is chosen to be that of a K meson. The results are relatively insensitive to the value chosen for the cutoff. (auth)

761 MANDELSTAM REPRESENTATION AND REGGE POLES WITH ABSORPTIVE ENERGY-DEPENDENT POTENTIALS. John M. Cornwall and Malvin A. Ruderman (Univ. of California, Berkeley). Phys. Rev., 128: 1474-84(Nov. 1, 1962).

The Mandelstam representation in potential theory is proved for superpositions of absorptive, energy-dependent Yukawa potentials. The dependence of the potential V(r,s) on the energy s is such that V(r,s) is analytic in the s plane cut from s_0 to infinity, where s_0 is a threshold for inelastic processes. Such a potential is implied by the causality condition that the scattered wave cannot precede the incident wave. Further, it is shown that certain interactions nonlocal in both space and time can also be reduced to the above type of local, energy-dependent potential. The postulate of absorptivity [$\mathrm{Im}V(r,s) \leq 0$] is crucial for the existence of the usual Mandelstam representation. The relationship of the absorptive potentials in the Schrödinger equation and in dispersion theory to unitarity is discussed. An analysis of partial waves with complex angular momenta is given from the point of view of the Green's function, and it is shown that absorptive energy-dependent causal potentials behave qualitatively like real energy-independent potentials, so far as Regge pole trajectories are concerned. Regge poles for emissive potentials can behave anomalously. Absorptive potentials may, however, give rise to new singularities in unphysical regions. (auth)

762 RELATIONSHIP BETWEEN VELOCITY-DEPENDENT POTENTIALS AND HARD-CORE POTENTIALS. George A. Baker, Jr. (Univ. of California, San Diego/La Jolla). Phys. Rev., 128: 1485-?(Nov. 1, 1962).

It is shown that, outside the range of the velocity dependence, the two-body wave function resulting from a repulsive velocity-dependent force is exactly the same as that produced by an angular-momentum dependent potential outside a hard core. (auth)

763 VECTOR CHARGE AND MAGNETIC MOMENT FORM FACTORS OF THE NUCLEON. Virendra Singh and Bhalchandra M. Udgaonkar (Univ. of California, Berkeley). Phys. Rev., 128: 1820-2(Nov. 15, 1962). (UCRL-10264)

The 2π contribution to the electromagnetic structure of the nucleon has been recalculated by use of a new method for evaluating the left-hand cut of the Frazer-Fulco amplitudes. Excellent agreement with experimental data has been obtained by using the experimental values for the position and the width of the ρ meson. (auth)

764 INELASTIC PROTON-PROTON SCATTERING AT 1.35, 2.1, AND 2.9 Bev. G. B. Chadwick, G. B. Collins, P. J. Duke, T. Fujii, N. C. Hien, M. A. R. Kemp, and F. Turkot (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 128: 1823-35(Nov. 15, 1962). (BNL-6261)

Absolute measurements have been made of the momentum spectrum of protons inelastically scattered from protons at incident kinetic energies of 1.35, 2.1, and 2.9 Bev, and at angles from 2° to 17° in the laboratory system. Peaks in these spectra were found at momenta corresponding to excitation of the resonances occurring in π-p scattering at 180-, 600-, and 900-Mev laboratory kinetic energies. A simple calculation of the inelastic spectra based on the one-pion-exchange (OPE) model is presented, and found to be in general agreement with the experimental data for values of the square of the invariant four-momentum transfer, Δ^2, less than $6m_\pi^2$. For larger values of Δ^2 the theory overestimates. When values of the differential cross section at the position of the $J = T = 3/2$ resonance are compared with predictions of the OPE calculation, the ratio is found to be a smooth function of Δ^2 out to a value of $55m_\pi^2$, the limit reached in this experiment. To within 20% this ratio appears to be independent of incident proton energy for our range of observation. The differential cross sections at the peaks corresponding to the $T = 1/2$ resonances are closer to the theoretical values than for the $T = 3/2$ resonance, for the same value of Δ^2. (auth)

765 ELASTIC PROTON-PROTON SCATTERING AT 1.35, 2.1, AND 2.9 Bev. T. Fujii, G. B. Chadwick, G. B. Collins, P. J. Duke, N. C. Hien, M. A. R. Kemp, and F. Turkot (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 128: 1836-41(Nov. 15, 1962). (BNL-6262)

As a part of our program to study p-p collisions at Cosmotron energies, the differential cross sections for elastic scattering were measured at five laboratory angles between 2.3° and 17° for each incident energy. Total elastic cross sections obtained by integration are 21.4 ± 1.4, 17.0 ± 0.8, and 14.7 ± 0.7 mb at 1.35, 2.1, and 2.9 Bev, respectively. The angular distribution as a function of the momentum transfer, exhibits a forward diffraction peak, the width of which shrinks slightly as the incident energy increases. The experimental results were fitted by simple optical model calculations and also compared with the predictions of the composite particle theory of Chew and Frautschi. (auth)

766 SCATTERING OF HIGH-ENERGY POSITRONS FROM PROTONS. D. Yount and J. Pine (Stanford Univ., Calif.). Phys. Rev., 128: 1842-9(Nov. 15, 1962).

Positron and electron beams from the Stanford Mark III linear accelerator have been used to investigate the importance of two-photon exchanges in electron scattering from the proton. The scattering cross sections for positrons and electrons have been compared at 200 and 300 Mev for q^2 (the square of the four-momentum transfer) from 0.3 to 5.2 F^{-2}. The results show no evidence of anomalous two-photon effects and verify the correctness of the first Born approximation form factor analysis to within a few percent or better for this range of q^2. The variation of the cross sections with q^2 has also been measured with high accuracy. The specific ionizations of 300-Mev positrons and electrons in hydrogen at one atmosphere have been compared in the course of the experiment, and found to be equal to within ±0.3%. (auth)

767 K^-p INTERACTIONS AT 1.15 Bev/c. William Graziano and Stanley G. Wojcicki (Univ. of California, Berkeley). Phys. Rev., 128: 1868-1880(Nov. 15, 1962). (UCRL-10177)

This paper contains the conclusion of the systematic study of K^-p interactions in the Lawrence Radiation Laboratory's 15-in. hydrogen bubble chamber at 1.15 Bev/c. In particular, the elastic and charge-exchange scattering, K^*N production, and $\Sigma\pi$ reactions are discussed. The procedure used in scanning, measuring, and computer analysis is described in detail. The similarity of total as well as differential cross sections for the three $\Sigma\pi$ charge states suggests predominant production from the $T = 0$ state for this channel. The angular distributions for the $\Sigma\pi$ reactions, as well as the elastic and charge-exchange scattering, indicate that partial waves as high as F_5 must be involved. The analysis of the $K^-p\pi^0$ reactions substantiates the earlier preliminary result of isotopic spin 1/2 for the K^* resonance. The angular distributions and correlations in the $K^-p\pi^0$ and $K^-\pi^+n$ reactions support the conclusion, derived from the previous study of $\overline{K}^0p\pi^-$ events, that the K^* spin is 0 or 1. A summary of cross sections for all the reactions studied in the experiment is given. (auth)

768 PION-NUCLEON SCATTERING AND PION-PION INTERACTIONS. J. Hamilton, P. Menotti, G. C. Oades, and L. L. J. Vick (University Coll., London). Phys. Rev., 128: 1881-1907(Nov. 15, 1962).

Low energy s- and p-wave π-N scattering is analyzed by partial wave dispersion relations. From the experimental $\pi-N$ phase shifts the "discrepancies" in the physical energy region and on the crossed cut are derived. The discrepancies are separated into the short-range ($\lesssim 0.2 \times 10^{-3}$ cm) $\pi-N$ interactions and the $\pi-\pi$ contributions to $\pi-N$ scattering. The $\pi-\pi$ contributions found in this way satisfy several stringent tests which show the validity of our method for deriving and separating the $\pi-\pi$ contributions. The (+) charge combination of s- and p-wave $\pi-N$ amplitudes yields considerable information about the $T = 0$ $\pi-\pi$ interaction at low energies. The $T = 0$, $J = 0$ $\pi-\pi$ scattering is dominant, and possible sets of the corresponding phase shift δ_0^0 are determined. Several of the solutions for δ_0^0 agree with recent solutions of the Chew-Mandelstam equations for $\pi-\pi$ scattering. Comparison with the latter suggests that the $\pi-\pi$ coupling parameter is $\lambda = -0.18 \pm 0.05$, and the $\pi-\pi$ scattering length is $a_0 = 1.3 \pm 0.4$ (in units where $\hbar = \mu = c = 1$). Other information, from the p + d and $\pi + N \rightarrow \pi + \pi + N$ experiments and from τ decay, is consistent with our proposed values of δ_0^0. The (–) charge combination of s- and p-wave $\pi-N$ amplitudes gives information about the $T = 1$, $J = 1$ $\pi-\pi$ interaction which is consistent with the observed ρ resonance. However in the $T = 1$ case, complete prediction of our $\pi-N$ results via the helicity amplitudes for $\pi + \pi \rightarrow N + \overline{N}$ is not yet satisfactory. Possible reasons for this are given. The p-wave $\pi-N$ interaction is separated into its constituent parts, and for example, it is seen that any attempt to determine the position of the $(3/2, 3/2)$ resonance must include the $T = 0$, $J = 0$ $\pi-\pi$ interaction. The extent to which the analysis depends on assuming charge independence is examined. How the results can be regarded as a fairly good physical proof of the Mandelstam representation is discussed. (auth)

769 PREDICTION OF PION PHASE SHIFTS. D. Atkinson (University Coll., London). Phys. Rev., 128: 1908-15(Nov. 15, 1962).

A method of deducing the pion-pion phase shifts from the pion-nucleon phase shifts is developed. A predominantly attractive S-wave interaction is found. A resonant P wave and an appreciable D wave are also deduced. (auth)

770 POSSIBLE TESTS OF THE TCP THEOREM IN PROTON-ANTIPROTON SCATTERING. Kazuo Gotow and Susumu Okubo (Univ. of Rochester, N. Y.). Phys. Rev., 128: 1921-7(Nov. 15, 1962). (NYO-10237)

Some experiments in elastic proton-antiproton scattering are suggested in order to test the TCP theorem, as well as the validities of the separate T, C, and P invariances. Also, a theorem has been proved that the total scattering cross section of two particles is equal to that of antiparticles, provided that the TCP theorem is valid. (auth)

771 $I = \frac{1}{2}$, $J = \frac{1}{2}$ STATE IN πN SCATTERING WITH THE NUCLEON AS A BOUND STATE. Louis A. P. Balázs (Univ. of California, Berkeley). Phys. Rev., 128: 1935-9 (Nov. 15, 1962). (UCRL-10026)

An approximate formula for the $I = \frac{1}{2}$, $J = \frac{1}{2}$ phase shift is derived. Assuming that the nucleon is a bound state, this formula depends only on the pion and nucleon masses, and the πN coupling constant (f^2). No purely phenomenological parameters are involved. The formula is roughly consistent with experiment in the 0- to 220-Mev range. (auth)

772 LOW-ENERGY PION-PION SCATTERING. Louis A. P. Balázs (Univ. of California, Berkeley). Phys. Rev., 128: 1939-44(Nov. 15, 1962). (UCRL-10157)

A general method for solving the problem of low-energy pion-pion scattering is presented. Within each partial wave, the nearby unphysical singularities are calculated by the usual Chew-Mandelstam approach, while the more distant ones are treated by a generalization of the Ball-Wong technique. These two techniques are then combined with the requirement of self-consistency. A rough calculation is given in which only a narrow P-wave resonance is retained and the only free parameter is the pion mass. The resulting resonance has a mass of 585 Mev and a half-width of 125 Mev. A method is also given for calculating Regge poles at low energies. (auth)

773 DYNAMICAL APPROACH TO THE SELECTION RULE $|\Delta I| = \frac{1}{2}$. E. R. McCliment and K. Nishijima (Univ. of Illinois, Urbana). Phys. Rev., 128: 1970-?(Nov. 15, 1962).

By giving up the unrenormalizable Lagrangian theory, the problem of weak interactions was studied by means of the unsubtracted dispersion relations. In this formalism the selection rule $|\Delta| = \frac{1}{2}$ in the nonleptonic decays of strange particles is shown to be a consequence of the charge independence of strong interactions. The unsubtracted dispersion relations further serve to determine the coupling constants in strong interactions as eigenvalues. Reasonable agreement with experiment was found for the nonleptonic hyperon decays for the even $\Sigma\Lambda$ parity. (auth)

774 THE EFFECT OF ATOMIC BINDING ON THE DECAY RATE OF NEGATIVE MUONS. I. M. Blair, H. Muirhead, T. Woodhead, and J. N. Woulds (Univ. of Liverpool). Proc. Phys. Soc. (London), 80: 938-44(Oct. 1, 1962).

A measurement of the decay rate of bound negative muons in several elements ranging from vanadium to lead is reported. The results are given as a fraction of the free decay rate. They contradict the anomalously high values previously obtained in the iron region by other workers, and are also in better agreement with recent theoretical predictions for the heavy elements. (auth)

775 A MEASUREMENT OF THE CAPTURE RATE OF NEGATIVE MUONS IN VARIOUS ELEMENTS. I. M. Blair, H. Muirhead, and T. Woodhead (Univ. of Liverpool). Proc. Phys. Soc. (London), 80: 945-6(Oct. 1, 1962).

A measurement of the lifetime and capture rate of negative muons in various elements is reported. The timing system was calibrated in terms of the accurately known positive muon lifetime. The values obtained are in reasonable agreement with previous experimental data, and have a comparable accuracy. (auth)

776 ČERENKOV RADIATION. R. E. Jennings (University Coll., London). Sci. Progr. (London), 50: 364-75 (July 1962).

The history of the discovery and theory of Cherenkov radiation is described. The origin and possible applications of Cherenkov radiation in high-energy physics are discussed together with detectors for detecting Cherenkov radiation. (D.L.C.)

777 A CLASSICAL PARTICLE MODEL WITH VARIABLE GRAVITATION COEFFICIENTS. Jochen Lindner (Universität, Mainz). Z. Naturforsch., 17a: 554-8(July 1962). (In German)

778 ON A POSSIBILITY OF DEVELOPING POLARIZED ELECTRONS. A. Ts. Amatuni (Erevan Inst. of Physics, Academy of Sciences, Georgian SSR). Zh. Tekhn. Fiz., 32: 1034-5(Aug. 1962). (In Russian)

It is postulated that under certain conditions the resonance effect related to s-d exchange can be utilized in the preparation of intense polarized electrons. (R.V.J.)

779 ON MONTE CARLO CALCULATIONS OF GAMMA ABSORPTION IN LATTICE SYSTEMS. V. A. El'tekov, B. M. Terent'ev, and D. I. Golenko. Zh. Vychislitel. Mat. i Mat. Fiz., 1: 1089-96(1961). (In Russian)

Previously the Monte Carlo method was successfully applied in resolving problems of γ or neutron diffusion in heterogeneous media with laminated geometry and for calculating cascades in photoemulsions. An attempt is made to apply the Monte Carlo method for calculating γ diffusion in a more complex system formed by infinitely long rods equidistant from each other and a medium filling the space between them. (R.V.J.)

780 THE EFFECT OF THE NUCLEON-ANTINUCLEON INTERMEDIATE STATE ON P-WAVE PION-PION SCATTERING RESONANCES. Johan Gijsbertus Frederik Belinfante. Thesis, Princeton, N. J., Princeton Univ., 1961. 103p.

The integral equations for pion-pion scattering are set up from first principles and solved by iterating, using analytical approximation techniques instead of numerical procedures. The effect of the nucleon-antinucleon intermediate state is investigated by using first-order perturbation theory and then the limits imposed by unitarity. The result obtained from perturbation theory seems to predict a resonance, but this false resonance can be eliminated by unitarity considerations. The analysis is based on a partial-wave approach whose singular aspects are reduced by limitation of the study to S and P waves. (Dissertation Abstr., 22: No. 7, 1962.)

781 PION PRODUCTION IN PION-NUCLEON COLLISIONS. Peter Ambler Carruthers. Thesis, Ithaca, N. Y., Cornell Univ., 1961. 163p.

The reaction $\pi + N \rightarrow 2\pi + N$ is studied in the vicinity of the higher resonances in the pion-nucleon cross section. The Low equation for the production amplitude is trans-

formed into an integral equation by isolating the true one-meson intermediate states and discarding higher order contributions. The only part kept in the inhomogeneous term corresponds to the collision of a pion in the nucleon cloud with the incident pion in the resonant T = J = 1 state, which is simulated by an unstable vector boson. Crossed terms are neglected and the 2π-N state is described by the static model. The terms kept in the sum over states describe the rescattering (off the nucleon) of one of the outgoing pions. The required off-the-energy-shell elastic scattering amplitude is approximated by the 3-3 resonance formula. With these simplifications the Low equation for the production amplitude reduces to an easily soluble linear integral equation. The rescattering amplitude, which dominates the inhomogeneous term in the resonance region, is proportional to the 3-3 scattering amplitude of one of the outgoing pions. Although the result provides some support for the isobar model, it is important to note that the largeness of the rescattering term arises from scattering far off the energy shell, rather than by "real" excitation as in the phenomenological isobar model. Quantitative calculations for the $D_{\frac{3}{2}}$ channel leading to a p-wave (J = 3/2) and an s-wave pion produce a maximum in the cross section near 600 Mev incident pion lab energy. For a π-π resonance energy squared (s) = 10, agreement with experiment is obtained with a width about one third that suggested by nucleon electromagnetic structure. In the examined approximation, the 600-Mev $D_{\frac{3}{2}}$ isospin-1/2 resonance occurs at the same energy as the 800-Mev $D_{\frac{3}{2}}$ isospin-3/2 resonance. It is assumed, but not proved, that the neglected terms are responsible for the splitting of the resonance energies. When this splitting is taken into account, the predicted charge state ratios near the second resonance agree with data. The "third" resonance occurs for the state having two p-wave pions, according to the derived theory, although no numerical calculations are made for this case. This point of view suggests that the $F_{\frac{5}{2}}$, $P_{\frac{3}{2}}$, and $P_{\frac{1}{2}}$ incident channels contribute to the third resonance. (Dissertation Abstr., 22: No. 7, 1962.)

782 ASSOCIATED PHOTOPRODUCTION OF POSITIVE K MESONS AND SIGMA HYPERONS FROM HYDROGEN AT 1140 Mev. Donald Andrew Edwards. Thesis, Ithaca, N. Y., Cornell Univ., 1961. 116p.

The differential cross section for the production of K^+ mesons in the reaction $\gamma + p \rightarrow K^+ + \Sigma^0$ is measured at three angles for 1140-Mev photons that pass through a liquid hydrogen target. K^+ mesons are selected by a magnetic spectrometer. After particles produced at the desired angle and momentum pass through the spectrometer magnet, K^+ mesons are identified by requiring proper pulse heights in several counters situated around an aluminum block in which the K mesons are brought to rest. The contribution to the yield from the process $\gamma + p \rightarrow K^+ + \Lambda^0$ is determined by lowering the end-point of the bremsstrahlung spectrum below the Σ^0 threshold. Differential cross sections in the center-of-mass system of (0.72 ± 0.10), (1.07 ± 0.18), and $(0.53 \pm 0.13) \times 10^{-31}$ cm^2 per steradian per photon, at center-of-mass angles for the K meson of 30, 85, and 120° respectively, are found. Statistical errors only are included in these results; systematic errors render the absolute cross sections uncertain by an additional 10%. The results on the reaction $\gamma + p \rightarrow K^+ + \Lambda^0$ tend to strengthen the isotropy of the cross section for this process at energies up to 100 Mev above threshold. A possible interpretation of the results, based on perturbation theory calculations, is presented. (Dissertation Abstr., 22: No. 7, 1962.)

783 CONTRIBUTION A L'ETUDE DE LA RETRODIFFUSION β. (Contribution to the Study of β Back Scattering). Louis Danguy. Monographie No. 10. Brussels, Institut Interuniversitaire des Sciences Nucléaires, 1962. 131p.

Beta backscattering is studied from a total viewpoint. Experimental studies on the intensity and angular distribution of backscattered β, with no consideration of energy, are first reported. A macroscopic theory on β scattering is then introduced. Experimental and theoretical studies on the energy distribution of backscattered electrons are described. It is shown that filtration of backscattered β improves sharply the methods for the measurement of the thickness of foils and for the determination of concentrations of binary solutions. Two new methods for the measurement of the thickness of foils are presented. In conclusion, works on β backscattering published previously are analyzed. (J.S.R.)

Neutron Physics

784 (AERE-R-3692) THE CORRECTION OF NEUTRON DIFFRACTION DATA FROM SINGLE CRYSTALS FOR THE EFFECT OF SECONDARY EXTINCTION. B. T. M. Willis (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Apr. 1961. 17p.

A method of correcting for secondary extinction which is based on the measurement of the total intensity for various path lengths of neutron beams in crystals is proposed. The theory of the method is developed for the cases of small and large extinction. The measurements are conveniently carried out using a 3-circle arrangement (Eulerian cradle); two of the circles are used, in effect, to bring the (hkl) normal into the reflecting position in the horizontal plane and the third circle to rotate the crystal about the normal to the reflecting plane, meanwhile maintaining the Bragg reflecting condition. The method is applied to the correction of the intensity data from single crystals of UO_2 and KBr. (auth)

785 (LAMS-2713) A DESCRIPTION OF A TIME DEPENDENT RADIATION HYDRODYNAMICS TRANSPORT CODE AND SOME NUMERICAL RESULTS. W. J. Byatt (Los Alamos Scientific Lab., N. Mex.). Aug. 1962. Contract W-7405-eng-36. 47p.

A description of a time-dependent radiation transport code is given. The transport equation is written in a form such that the flow of radiation is along the characteristics in space-time. Energy conservation, the equation of state, and the hydrodynamic equations are written in a finite difference form. Numerical results to several problems of varying degrees of complexity are given. (auth)

786 (LAMS-2747) A CODE FOR REDUCING MANY-GROUP CROSS SECTIONS TO FEW GROUPS. Ralph S. Cooper (Los Alamos Scientific Lab., N. Mex.). Sept. 11, 1959. Contract W-7405-eng-36. 13p.

A code (ZOT) was written that will produce few group neutron cross sections from many group sets based on a given flux spectrum or one computed for an infinite medium. The cross-section format is that of S_n transport theory including the possibility of upscattering in energy. The code is written in the Floco II system for use on the IBM 704. In October 1962 this code will be rewritten for production use and compatibility with the IBM 7090. A FORTRAN version is also planned. (auth)

787 (AEC-tr-5413) NEUTRON PROPAGATION IN THE NICKEL SCREEN OF A FAST REACTOR. M. N. Nikolaev, V. I. Golubev, A. A. Abagyan, and M. Yu. Orlov. Translated from p.65-74 of "Proceedings of the Seminar on the Physics of Fast and Intermediate Reactors, held in Vienna, August 3-11, 1961. Vol. I" (a publication of the International Atomic Energy Agency, Vienna, 1962. (STI/PUB/49(Vol.I(p.65-74)). 14p.

Neutron propagation in various materials is studied in order to refine and check the system of constants used in multigroup fast reactor calculations. Nickel is studied primarily since it is widely used as a construction material and as a screen material, e.g., the BR-5 reactor. The distribution of neutrons of various energies over the radius of the reactor's nickel screen was measured with an assembly of detectors with various energy sensitivities. Results are compared with 18-group calculations made with a P_1 approximation. The comparison shows that the results of the experiment tally satisfactorily with the calculation. The results of an analysis of the transmission curves are presented for aluminum, sulfur, iron, nickel, copper, zirconium, niobium, molybdenum, lead, bismuth, and thorium in the energy interval from 0.3 to 2.7 Mev. (auth)

788 ONE ASYMPTOTIC REGULARITY IN NEUTRON MODERATION THEORY. M. V. Maslennikov. Zh. Vychislitel. Mat. i Mat. Fiz., 1: 1136-9(1961). (In Russian)

Time-energy distribution of slowed neutrons in a homogeneous moderator with stationary nuclei of mass M (the neutron mass is taken as a unit) is analyzed. The neutron state is determined by a given point (u,t), where t is time, u is neutron lethargy; $(u,t) \in D$, $D = [(u,t)/u > 0, t > 0]$. It is assumed that neutrons are captured and scattered by moderator nuclei; moreover, the scattering is elastic and isotropic in the neutron and nucleus center of mass. Certain regularities in the slowing down problem are indicated and a precise asymptotic law for neutron distribution for the given lethargy at $t \to \infty$ is sought. (R.V.J.)

789 EFFECTS OF FLUX ANISOTROPY ON THE NEUTRON GAS TEMPERATURE. L. V. Mairov. Zh. Vychislitel. Mat. i Mat. Fiz., 2: 349-50(1962). (In Russian)

Neutron distribution in a medium consisting of two infinite semispaces, where one has T_1 and the other T_2 temperature, was resolved previously in diffusion approximation, considering the neutron flux $\psi(\xi,\chi,\mu)$ as sufficiently isotropic. The same problem is analyzed without considering such anisotropy. It is also assumed that 1) the neutron scattering cross section is not a function of the angle of scattering, 2) the neutron moderating mechanism is described by a heavy monoatomic gas model, and 3) absorption is not present. (R.V.J.)

790 GENERALISATION OF WILKINS' NEUTRON THERMALIZATION THEORY TO HETEROGENEOUS MEDIA. Hans Maerkl (Siemens-Schuckertserke Aktiengesellschaft, Erlangen, Ger.). Preprint. [Ottawa], Canadian Nuclear Association, 1962. 17p.

A two-zone Wilkins' calculation is carried out for a heterogeneous media. As an example, it has been applied to a lattice of natural U metal fuel and a D_2O moderator. Taking into account the fact that the lattice investigated in this paper was treated with a most primitive approximation, it is concluded that the multi-zone Wilkins' theory should permit the calculation of thermal spectra in heterogeneous cells with a sufficient degree of accuracy. If spatially constant source densities are assumed in calculating the collision probabilities, the different zones of the cell should not have unduly large dimensions. (A.G.W.)

Nuclear Properties and Reactions

Refer also to abstract 399.

791 (AERE-NP/R-1996) FISSION CROSS-SECTIONS OF U^{238}, U^{235}, U^{233}, Pu^{239}, AND Th^{232} FOR 14 Mev NEUTRONS. C. A. Uttley and J. A. Phillips (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). June 26, 1956. 10p.

Relative and absolute fission cross-sections for 14 Mev neutrons were measured for the following isotopes using a back to back fission chamber: U^{238}, U^{235}, U^{233}, Pu^{239}, and Th^{232}. The ratios of fission rates obtained with various U^{238} foils, irradiated in the same neutron flux, were compared with the mass ratios of the deposits. Values of the fission cross-sections at 14 Mev are included. (auth)

792 (AWRE-NR/P-2/62) DOUBLE COULOMB EXCITATION IN EVEN NUCLEI TABLES OF CROSS-SECTION FUNCTIONS. A. C. Douglas (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Sept. 1962. 109p.

The theory of double Coulomb excitation was previously developed in the review article of Alder, Bohr, Huus, Mottelson, and Winther in the semi-classical approach using second order perturbation theory. This formalism is applied to double E2 excitation in even nuclei. Tables are given of the functions required to calculate the total and differential cross sections for double E2 excitation from the spin 0 ground state by way of a spin 2 intermediate state, to a final state of spin J, J = 0, 2, 4. Only one intermediate state is considered of importance. Also tabulated are certain auxiliary functions. (auth)

793 (AWRE-0-71/60) NEUTRON CROSS-SECTIONS OF CARBON IN THE ENERGY RANGE 0.025 ev–15 Mev. K. Parker (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Aug. 1961. 37p.

Recommended values are given for the neutron total and partial cross sections of carbon in the energy range 0.025 ev to 15 Mev based on available experimental and theoretical evidence. Details of energy and angular distributions are given so that the data are complete for the purpose of neutronics calculations. The values given are available on punched cards as part of the AWRE Punched Card Library of Neutron Cross Sections. (auth)

794 (CERN-62-22) COLLECTION OF DATA FOR SPECTROSCOPIC ANALYSIS OF INDUCED ACTIVITY. M. Barbier and J. Dutrannois (European Organization for Nuclear Research, Geneva). July 3, 1962. 32p.

Data were assembled to assist in identifying radioactive nuclei by gamma spectroscopy for the study of induced radioactivity in accelerators. A list of the radioactive elements produced when the main elements used in the construction of these machines are bombarded by high-energy protons or neutrons. The tables also include the order of magnitude of the production cross sections observed for bombardment at energies between 370 and 500 Mev. The half lives, kinds of radiation emitted, and energies are given. (M.C.G.)

795 (CERN-62-27) PARTICLE PRODUCTION AT 45° AND 60° IN THE CERN PS. J. D. Dowell, R. H. Good, B. Leontic, A. Lundby, R. Meunier, and J. P. Stroot (European Organization for Nuclear Research, Geneva). Aug. 30, 1962. 8p.

Results are presented of particle production at 45 and 60° from the internal beryllium target of the CERN proton synchrotron. The experimental setup is described along with the properties of the measuring equipment. The results for pion and proton production are qualitatively consistent with measurements by Fitch et al., though the absolute values are higher by a factor of about two. The K^+/K^- intensities between 0.8 and 1.8 Bev/c stays approximately constant at 6 ± 1 at both production angles. The fluxes of pions, K^+, and protons are graphically presented along with the ratios of $\bar{p}$ to π^- intensity. (N.W.R.)

796 (NEVIS-109) A STUDY OF (p,pn) REACTIONS IN MEDIUM WEIGHT NUCLEI AT 370 Mev. Louis P. Remsberg, Jr. (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). Sept. 1962. Contract AT(30-1)-1019. 42p. (CU-34-62-AEC-1019-Chem)

Cross sections for the (p,pn) reaction at a proton energy of 370 Mev were measured with Sc^{45}, Cr^{50}, Cr^{52}, Mn^{55}, Fe^{56}, Ni^{58}, Co^{59}, Cu^{65}, Ga^{69}, and Ga^{71} targets. All of the (p,pn) cross sections, except those for Sc^{45}, Cr^{50}, and Ni^{58}, were found to be about sixty millibarns. No quantitative explanation could be found for these three divergent cross sections, all of which are lower than the others. Cross sections for (p,2n) reactions on Cr^{52} and Fe^{56} were also measured. Calculations based on the (p,2n)–(p,pn) ratio show that at least 85% of the (p,pn) reactions proceed by a pure knock-on mechanism. (auth)

797 (NP-12129) ENERGY AND ANGULAR DISTRIBUTIONS OF THE NEUTRONS FROM STRIPPING REACTION $^{12}C(d,n)^{13}N$. N. Kolonko, Z. Lewandowski, M. Makowska-Rzeszutko, H. Niewodniczański, S. Wiktor, and Z. Wróbel (Polish Academy of Sciences. Inst. of Nuclear Physics, Krakow). July 1962. 15p.

The angular distributions for some neutron energy groups from the $C^{12}(d,n)N^{13}$ reaction were measured for 15 angles from 0° to 161° in the center-of-mass system. Three groups of neutrons, connected with the ground, first, and third excited states of the final N^{13} nucleus were resolved. The energy of the incident deuteron beam was (13.00 ± 0.16) Mev. Neutrons were registered by means of the nuclear emulsion technique. The absolute values of the differential cross sections are given for the three neutron groups. The reduced widths of the corresponding N^{13} levels were evaluated using the simple plane wave Butler-Born approximation. A comparison with data obtained by other authors is given. (auth)

798 (ORNL-TM-388) SPECIFIC ACTIVITIES OF HIGHLY IRRADIATED PLUTONIUM. E. D. Arnold (Oak Ridge National Lab., Tenn.). Oct. 4, 1962. Contract [W-7405-eng-26]. 7p. (CF-59-12-8)

Specific activities of individual Pu isotopes and the specific activity of the average of the last H-240 Pu products were calculated. Results are presented tabularly. (J.R.D.)

799 (TID-16950) GAMMA-RAY TRANSITIONS IN ^{32}S FOLLOWING PROTON CAPTURE BY ^{31}P. P. R. Chagnon and P. A. Treado (Michigan. Univ., Ann Arbor). [1962]. Contract AT(11-1)-1112. 15p.

Gamma spectra, angular distributions, and coincidence spectra were studied in the reaction $P^{31}(p,\gamma)S^{32}$ at bombarding energies of 355, 440, and 540 kev. Several cascades were identified and branching ratios were measured. The spins and parities of the 9.39, 9.29, 9.21, and 4.70 Mev levels in S^{32} were found to be $2^{(-)}$, 1^+, (1^+), and 1^+, respectively. (auth)

800 (TID-16960) BETA-GAMMA DIRECTIONAL CORRELATION MEASUREMENT IN As^{76}. H. J. Fischbeck and R. W. Newsome, Jr. (Michigan Univ., Ann Arbor. Harrison M. Randall Lab. of Physics). [1962]. Contract AT(11-1)-1112. 35p.

The β-γ directional correlation of the first forbidden nonunique $2^- \rightarrow 2^+$ β transition of As^{76} was measured at ten β energies ranging from 1.33 to 2.18 Mev. The angular correlation coefficient $A_2(W)$ varied from 0.076 ± 0.005 to 0.106 ± 0.005 in this energy range. The modified B_{ij} approximation was used to investigate the structure of the first excited state in Se^{76}. A configuration of either $(f_{\frac{5}{2}})^7(g_{\frac{9}{2}})^2$ or $(f_{\frac{5}{2}})^2(g_{\frac{9}{2}})^7$ was in agreement with the experimental data. The values $-2.2 < Y < -2.8$ and $-3.2 < V < 4.2$ for the nuclear matrix element parameters were consistent with an analysis of the experiment in the ξ approximation and the modified B_{ij} approximation. (auth)

801 (TID-16963) DOUBLE COULOMB EXCITATION WITH OXYGEN IONS. R. Graetzer and E. M. Bernstein (Wisconsin. Univ., Madison). [1962]. Contract [AT (11-1)-881]. 31p.

Total cross sections for Coulomb excitation of the first and second excited states of the ground state rotational bands of eight even-even rare earth nuclei were measured. Oxygen ions accelerated to energies in the range 14 to 50 Mev produced the nuclear excitations. The transitions from the second excited state (4^+) to the first (2^+), and from the first to the ground state (0^+), were detected by analyzing the emitted internal conversion electrons in a wedge-shaped magnetic beta ray spectrometer. Cross sections for excitation of the 2^+ levels yield B(E2) values in satisfactory agreement with those obtained from lifetime measurements and from inelastic scattering of protons, deuterons, and alpha particles. Cross sections for double E2 excitation of the 4^+ levels are in qualitative agreement with the multiple Coulomb excitation theory of Alder and Winther. The energies of the 4^+ levels are Sm^{152}, 366.2 kev; Sm^{154}, 267.1 kev; Gd^{160}, 248.6 kev; Dy^{162}, 266.0 kev; Er^{170}, 261.5 kev; Yb^{176}, 271.9 kev; Hf^{180}, 309.4 kev; and W^{184}, 363.4 kev. In all cases the uncertainty is ±2 kev. (auth)

802 (TID-16965) POLARIZATION IN STRIPPING REACTIONS. W. Haeberli (Wisconsin. Univ., Madison). [1962]. Contract [AT(11-1)-Gen-7]. 31p.

The classical model of Newns gives a qualitative understanding of the processes that lead to polarization of the outgoing nucleons in deuteron stripping reactions. The method of observing the polarization in (d,p) reactions is discussed. The results of experiments and of distorted wave calculations with optical model potentials are summarized. The case in which the orbital angular momentum l_c of the captured nucleon is equal to zero was considered. Experimental results on several (d,p) reactions indicated that spin-dependent forces are important. Calculations which use an optical model potential with a spin-orbit term give in some cases reasonable qualitative agreement with experiment. Results of experiments and calculations for transitions where $l_c \geq 1$ are also mentioned. (auth)

803 (TID-16971) POLARIZATION CORRELATIONS FOLLOWING THE DECAY OF Ge^{77}. M. B. Martin and M. L. Wiedenbeck (Michigan. Univ., Ann Arbor). [1961]. Contract AT(11-1)-1112. 19p.

An investigation was made of the gamma-gamma directional correlation and gamma-gamma polarization-directional correlation in the decay of 12-hr Ge^{77}. The preparation of sources and the apparatus are described. Results are presented in tables and graphs. The experimental data were best fitted by a large quadrupole content of the 563-kev radiation, the allowed values of the spin of

the 1.19-Mev level being $^5/_2$ or $^7/_2$. The polarization measurements on the 563 kev-632 kev cascade did not allow either one of the possible cases to be ruled out. (M.C.G.)

804 (TID-16974) AN EXPERIMENTAL DETERMINATION OF THE SPIN EXCHANGE CROSS SECTIONS OF Rb^{85}, Rb^{87} AND Cs^{133} (thesis). Henry Warren Moos (Michigan. Univ., Ann Arbor). 1961. Contract AT(11-1)-1112. 118p.

The spin exchange cross sections of Rb^{85}, Rb^{87}, and Cs^{133} were measured using paramagnetic resonance techniques to examine the Zeeman transitions of these alkalis. The collision frequency was determined from the width of the absorption lines and the density of atoms by comparing the intensity of the signal with a $CuSO_4 \cdot 5H_2O$ crystal in the same cavity. The spin exchange cross sections of Rb^{85}, Rb^{87}, and Cs^{133} are 2.0, 1.9, and 2.3×10^{-14} cm^2. The 70% probable error is ±20%. The extreme limits of error are felt to be +70% and −90%. The thermal relaxation times were measured also, and it was found that they were best explained by the strong exchange coupling and an admixture of a not unreasonable amount of excited p state into the wave function during collision. The thermal relaxation cross section did not contribute significantly to the measured spin exchange cross sections. This technique may be extended to the other alkalis and similar species with net electronic spin. (auth)

805 (TID-16984) DECAY OF Se^{81m} AND Se^{81}. R. E. Sund and M. L. Wiedenbeck (Michigan Univ., Ann Arbor. Harrison M. Randall Lab. of Physics). [1960]. Contract AT(11-1)-1112. 23p.

The gamma rays in Se^{81} and Br^{81} following the decay of Se^{81m} and Se^{81} were studied with a magnetic spectrograph. Three internal conversion lines were observed in these measurements. Gamma spectra taken with a NaI(Tl) detector indicated a transition at 30 kev in addition to previously reported gamma rays. Measurements were made of spectra of gamma rays in coincidence with gamma rays in five energy regions. The results indicate levels at 280, 560, and 832 kev in Br^{81} and agree with the main features of the decay scheme proposed by Krause et al. Intensities of the transitions were computed. Beta-gamma coincidence measurements showed that the 560 kev level in Br^{81} is a different level than the 550 kev level which is excited in (p,γ) and (γ,γ′) reactions. (auth)

806 (TID-16985) NEUTRON-CAPTURE GAMMA RAYS. P. A. Treado and P. R. Chagnon (Michigan. Univ., Ann Arbor). [nd]. Contract AT(11-1)-1112. 9p.

The neutron-capture gamma-ray spectrum of chlorine was studied to determine the feasibility of using the 400 kev Van de Graaff as a generator of slow neutrons for doing (n,γ) experiments. Fast neutrons, generated by the accelerator in the $T(d,n)He^3$ reaction, were moderated by water and paraffin. NaI(Tl) detectors were used to study the chlorine spectrum. Both single and coincidence spectra were observed and the results agree qualitatively with previously published work. The results, however, indicate that the accelerator-moderator system can not compete with the reactor-chopper system for generating slow neutrons for (n,γ) experiments. (auth)

807 (TID-16989) A COMPUTER PROGRAM USEFUL IN THE ANALYSIS OF GAMMA SPECTRA AND ANGULAR CORRELATION DATA. R. M. Woods, Jr. and M. L. Wiedenbeck (Michigan Univ., Ann Arbor. Harrison M. Randall Lab. of Physics). [1961]. Contract AT (11-1)-1112. 5p.

A computer program for least squares analysis of gamma spectra and angular correlation data is described. The program determines the best values and errors of the gamma ray intensities or of the angular correlation coefficients. The program is written in the FORTRAN language for the IBM 709 machine. It occupies about 24,000 locations in the memory. (auth)

808 (UCRL-7084-T) ANALYSIS OF MULTICOMPONENT RADIOACTIVE DECAY CURVES. Robert E. Shafer (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 1962. Contract W-7405-eng-48. 23p.

Methods of analysis of multicomponent decay curves are reviewed. A method is proposed in which the function is considered a polynomial of arbitrarily high degree. Successive approximations are obtained by considering Legendre polynomials. This analysis employs the method of examining each section of the decay curve piecewise. Since the analysis employs equal time intervals, it appeared to be possible to take a long count so that statistical errors are minimized and the data represent the integrated sum of all components of the sample. (M.C.G.)

809 (UCRL-9036(Rev.)) A REVIEW OF NUCLEAR FISSION. PART ONE. FISSION PHENOMENA AT LOW ENERGY. Revised Edition. Earl K. Hyde (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1962. Contract W-7405-eng-48. 360p.

The discovery of fission is described, and fission theory is outlined. The probability of fission is discussed. Distribution of mass and nuclear charge in fission is considered. Measurements of the kinetic energy of fission fragments are described. The emission of prompt neutrons, delayed neutrons, and gamma rays in fission is discussed. (M.C.G.)

810 (WASH-1039) REPORTS TO THE AEC NUCLEAR CROSS SECTIONS ADVISORY GROUP [AT] BROOKHAVEN NATIONAL LABORATORY, MAY 14-15, 1962. John R. Stehn (Brookhaven National Lab., Upton, N. Y.). Contract [AT(30-2)-Gen-16]. 45p.

Recent developments, changes of emphasis, and preliminary data which are of importance to the cross-section-measurement program of the AEC are discussed. (M.C.G.)

811 DECAY SCHEME OF Fe^{59}. Martti Kantola and Vaeinoe Sutela (Univ. of Turku, Finland). Ann. Acad. Sci. Fennicae, Ser. A, VI, No. 107, 1-12(1962). (In English)

The gamma spectrum of Fe^{59} was investigated with scintillation counters and coincidence techniques. Gamma rays at 0.15, 0.20, 1.10, and 1.29 Mev were observed. Between the lines of 1.10 and 1.29 Mev no genuine coincidences could be detected. Coincidences between the gamma rays at 0.15 and 1.10 Mev, 0.15 and 1.29 Mev, and 0.20 and 1.10 Mev were observed. The positions of these gamma rays in the decay scheme were established from the gamma energies and coincidence measurements. (auth)

812 THE MACROSCOPIC MOTION OF RADIOACTIVE BODY IN THE CASE OF NONCONSERVATION OF PARITY. Mirosław Kozłowski. Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia: Sect. AA, 15: 105-12(1960). (In Polish)

The influence of nuclear recoil asymmetry on the motion of a macroscopic radioactive body is investigated under the assumption of nonconservation of parity in K-capture. It is shown that when a body is placed in a homogeneous magnetic field and cooled to 0.01°K the effective acceleration is given by $g^1 = g - (\beta v_0/2M) - (2\pi/3)\ (N_0\lambda\bar{p}\alpha/M)$, where $(2\pi/3)\ (N_0\lambda\bar{p}\alpha/M) = 0.2$ for Be^7. (auth)

813 PRODUCTION OF RADIONUCLIDES BY BOMBARDMENTS WITH POSITIVELY-CHARGED PARTICLES. D. F. C. Morris (Brunel Coll., London) and D. N. Slater. Chem. & Process Eng., 43: 442-7(Sept. 1962).

Bombardment with positively charged particles may produce radionuclides which cannot be produced readily in a reactor. Means of accelerating positively charged ions are discussed. The radionuclides which may be produced by charged particle reactions are tabulated together with these of the same elements produced in a reactor. One common reaction is (d,p), which gives the same product as (n,γ). Reactions with p,α, He^3, and heavy accelerated ions are considered; the latter may be used to produce heavy elements. (D.L.C.)

814 EXCITATION OF C^{12} NUCLEI BY 660 Mev PROTONS. L. S. Ashgirei (United Inst. of Nuclear Studies, USSR), Yu. P. Kumekin, M. G. Meshcheryakov, S. B. Nurushev, G. D. Stoletov, and De-Tsyan Huan. Doklady Akad. Nauk SSSR, 145: 1249-52(Aug. 21, 1962). (In Russian)

The energy spectrum of secondary particles from p + C collisions was measured at small angles of 4.2, 5.2, 7.0, 8.3, 9.1, and 10.7° in order to separate the diffraction scattering of protons on carbon nuclei from the corresponding inelastic processes. The beam of secondary particles, scattered at an angle θ, was directed to the center of an analyzing magnet, and was counted either by a telescope consisting of three scintillation counters, or by an ionization chamber filled with argon. The inelastic scattering contribution was determined by subtracting out the p-p elastic scattering contribution. The energy most frequently imparted by the proton to the C^{12} nucleus corresponds to that of the giant photoresonance for C^{12}, but the width of the spectrum at half-height, which was 30 Mev at an angle of 5.2° and 50 Mev for an angle of 10.7°, was significantly wider than the giant photoresonance of C^{12}. At 7° the differential inelastic scattering cross-section is $\sim 130 \times 10^{-27}$ cm^2/sterad. Collective excitations of the nucleus which do not occur in photonuclear transitions make a noticeable contribution during the scattering of 660-Mev protons by C^{12} nuclei at small angles. (TTT)

815 THE MASSES OF THE ISOTOPES OF LUTETIUM, YTTERBIUM AND THULIUM. R. A. Demirkhanov, V. V. Dorokhov, and M. I. Dzkuya. Dokl. Akad. Nauk SSSR, 146: 72-4(Sept. 1, 1962). (In Russian)

The masses of rare-earth chlorides were measured on a double-focusing, mass spectrograph. Doublets formed by the rare-earth ion and an organic compound consisting of H^1, C^{12}, C^{13}, N^{14}, and O^{16} were used to determine the mass of the rare-earth isotope. Since an organic fragment containing the C^{13} isotope was resolved on the mass-spectrograph used, it was not necessary to correct for the C^{13} content in the organic sub-standard. In fact, an organic fragment containing the C^{13} isotope was used as a substandard to determine the mass of the unknown rare-earth isotope, if its intensity was high enough. The average, relative accuracy with "internal" self-consistency of the results gave a $\Delta M/M = 2$ to 5×10^{-7} (30 to 80 kev). The masses of rare-earth isotopes from Tm^{169} to Lu^{176} are listed in tabular form. Anthracene, α-nitroso-β-napthol, and diphenylamine were used as sub-standards. The mass of the Tm^{169} isotope was controlled by measuring the doublet between $Tm^{169}Cl^{35}$ and Hg^{204}. The dispersion was calculated by means of the $Hg^{204}H$ and $Hg^{202}H$ ions. The values of the rare-earth isotopic masses are in good agreement with the values of A. O. Nier et al., as reported in Phys. Rev., 120: No. 1, 235(1960). (TTT)

816 LOW ENERGY SCATTERING OF ELECTRON BY VARIATIONAL METHOD. S. C. Mukherjee and N. C. Sil (Indian Assn. for the Cultivation of Science, Calcutta). Indian J. Phys., 36: 283-9(June 1962).

The cross section for elastic scattering of slow electrons by helium is calculated, with allowance for exchange effect. Wave functions having two sets of parameters are taken for the ground state of helium. The phases are calculated by the variational method from the differential equation. (auth)

817 NUCLEAR REACTIONS. A. Kraut. Kerntechnik, 4: 351-3(Aug. 1962). (In German)

Examples of nuclear reactions are given (neutron capture, neutron moderation, and radioactive decay). Nuclear technology is the application of nuclear reactions. Nuclear reactions are divided into natural and forced reactions; the latter may or may not involve intermediate nuclei. Various ways of bringing about forced reactions are described. (D.L.C.)

818 PUNCH-CARD SYSTEM FOR THE MOST IMPORTANT FEATURES OF RADIOACTIVE NUCLIDES. Ferenc Illés and Endre Vatai. Magy. Tud. Akad. At. Kut. Int. (Debrecen) Kozlemen., 4: 45-9(May 1962). (In Hungarian)

A punch-card system nuclide catalog was made by means of which a rapid identification of radioactive nuclides is possible, provided a sufficient number of decay data are known. Identification is affected on the basis of the half life and the energy of the beta and gamma transition. (auth)

819 NEUTRON IRRADIATION OF ^{237}Np. Eiko Nakamura (Japan Atomic Energy Research Inst., [Tokyo]). Nippon Genshiryoku Gakkaishi, 4: 585-7(Sept. 1962). (In English)

Irradiation activity measurement of Np^{237} clarified that Np^{238} was formed as a consequence of neutron capture. The identification was carried out by tracing the decay and by β and γ spectrometry. Gamma rays from fission products did not interfere with the measurements. Np^{238} decays into Pu^{238}, so Pu^{238} was isolated chemically from the target material after suitable cooling time, and its presence was confirmed by α spectrometry. (auth)

820 EFFECTIVE SURFACE AREA IN RESONANCE INTEGRAL CALCULATION FOR FUEL CLUSTER. Yuzo Fukai (Nippon Atomic Energy Industrial Group, Co., [Tokyo]). Nippon Genshiryoku Gakkaishi, 4: 593-600 (Sept. 1962). (In English)

In resonance integral calculations for a fuel-rod cluster, the rubber-band-surface method is frequently used for calculating its effective surface area. This method, however, is not theoretically rigorous. The Dancoff correction is derived, using the narrow and wide approximations. The surface area derived by the rubber-band-surface method is compared with that derived by the Dancoff correction method. A method for calculating the effective surface area for the cluster, which is in agreement with the Dancoff-correction method, is suggested. (auth)

821 NUCLEAR SUSCEPTIBILITY OF LIQUID HELIUM-3 UNDER PRESSURE. A. Low Thomson, Horst Meyer, and E. Dwight Adams (Duke Univ., Durham, N. C.). Phys. Rev., 128: 509-14(Oct. 15, 1962).

New measurements of the nuclear susceptibility of liquid helium-3 between 0.045 and 1.3°K and up to 30.7 atm will be described. At the lowest temperatures, the susceptibility for all pressures has almost reached a constant value. The effective Fermi temperature T_f^* from these measurements is found to vary from 0.43°K at 0.5 atm to about 0.26°K at 30.7 atm. From these measurements and recent specific-heat data of several authors, the spin-dependent exchange constant is calculated and is found to decrease with increasing pressure and density. The spin specific heat calculated from susceptibility according to Goldstein's theory is compared to available data. The sus-

ceptibility results are compared to recent data of Anderson, Reese, and Wheatley. (auth)

822 NUCLEAR MAGNETIC RESONANCE AND RELAXATION OF FOUR SPIN MOLECULES IN A LIQUID. Paul S. Hubbard (Univ. of North Carolina, Chapel Hill). Phys. Rev., 128: 650-8(Oct. 15, 1962).

The semiclassical form of the density operator theory of relaxation is employed to calculate the longitudinal and transverse relaxation and the resonance line shape of a liquid sample whose molecules contain four identical spin $\frac{1}{2}$ nuclei at the corners of an equilateral tetrahedron. The relaxation is assumed to be due to the time dependence of the intramolecular dipole-dipole interactions that results from the classical rotational diffusion of the molecules. The calculation is not restricted to correlation times shorter than the Larmor period, but it is restricted to correlation times much shorter than the reciprocal coupling frequency. The second-order correction to the Zeeman energy due to the dipole-dipole interactions is included. The longitudinal relaxation is found to be, in general, the sum of three exponentials decaying with different time constants, but in the limit of either short or long correlation time there are only two exponentials. The expression for short correlation time agrees with the author's previous calculation. The transverse magnetization $M_x + iM_y$, in the absence of a radio-frequency field, is, in general, found to be the sum of three terms each precessing with slightly different frequencies and decaying exponentially with different time constants. In the case of short correlation time the precession frequencies are the same, and the amplitude decays in the same manner as the longitudinal magnetization for short correlation time. The resonance line shape, correct to first order in the magnitude of the radio frequency field, can be expressed in terms of a complex susceptibility $\chi = \chi' + i\chi''$, which is shown to be proportional to $\int_0^\infty [M_x(t) + iM_y(t)] \exp(i\omega t)dt$, where $M_x(t) + iM_y(t)$ is the transverse magnetization after a 90° pulse. The saturation behavior of the resonance line shape is calculated for the case of short correlation time. The numerical values occurring in the expressions for the longitudinal and transverse relaxation and the resonance line shape are such that there is little difference between the results calculated here and the results obtained by neglecting in the calculation the effects of the correlations of different dipole-dipole interactions with one another. (auth)

823 VELOCITY DEPENDENCE OF THE TOTAL CROSS SECTION FOR THE SCATTERING OF Li AND K BY Xe. Erhard W. Rothe, P. K. Rol, S. M. Trujillo, and R. H. Neynaber (General Dynamics/Astronautics, San Diego, Calif.). Phys. Rev., 128: 659-62(Oct. 15, 1962).

The velocity dependence of the total cross section has been measured for the scattering of potassium by xenon at relative velocities between 350 and 1550 m/sec, and for the scattering of lithium-7 by xenon between 700 and 3800 m/sec. Although small deviations were seen, the potassium-xenon scattering was in general agreement with the Massey-Mohr theory, assuming an inverse sixth power interatomic potential. Large deviations from this theory were observed for the lithium-xenon scattering. To account for these deviations, phase shifts were calculated in the semiclassical framework of Ford and Wheeler, following a method of Bernstein. The Lennard-Jones interatomic potential was assumed. The velocity dependence of the cross sections which were calculated from the phase shifts shows the qualitative features of the experimental results. (auth)

824 SECOND-ORDER EFFECTS OF NUCLEAR MAGNETIC FIELDS. Morton M. Sternheim (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 128: 676-7 (Oct. 15, 1962).

Using the Dirac equation, the contributions to atomic levels of terms quadratic in A are considered. A may be, for example, the nuclear magnetic dipole field. It is shown that a consistent quantum mechanical treatment cancels all terms arising from $[A_i, A_j] \neq 0$. This resolves a disagreement between hyperfine structural corrections calculated nonrelativistically and relativistically. (auth)

825 DECAY OF Tl^{199} AND Au^{199}. R. W. Bauer, L. Grodzins, and H. H. Wilson (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 128: 694-9(Oct. 15, 1962). (TID-15938)

The decays of Tl^{199} to Hg^{199} and Au^{199} to Hg^{199} have been examined using gamma-ray coincidence spectrometry and angular correlation techniques. The level order as well as level spins of Hg^{199} deduced from this study support the recent work of Jung and Svedberg. The branching ratios of the electron capture transitions from Tl^{199} to six levels in Hg^{199} have also been determined. Particular emphasis was placed on obtaining the empirical parameters of importance to the measurement of the magnetic moment of the 158-kev first excited state in Hg^{199} as well as to the interpretation of the state as one member of a doublet resulting from coupling the $\frac{1}{2}^-$ ground state with the 2^+ core excitation. This interpretation, due to de-Shalit, implies the interrelations of some of the magnetic moments and lifetimes of the states involved. This study supports such an interpretation. (auth)

826 FURTHER RADIOCHEMICAL STUDIES OF FISSION OF THE U^{236*} COMPOUND NUCLEUS. H. G. Hicks, H. B. Levy, W. E. Nervik, P. C. Stevenson, J. B. Niday, and J. C. Armstrong, Jr. (Univ. of California, Livermore). Phys. Rev., 128: 700-7(Oct. 15, 1962). (UCRL-6479)

Fission-product yields relative to the fission yield of Mo^{99} were measured for the fission of Th^{232} with He^4 ions of energies ranging from threshold to 45 Mev and for the fission of U^{235} with 14-Mev neutrons. The linear relationships between fission yields predicted by the two-mode fission hypothesis and previously observed for fission of U^{236*} at low excitation energies break down at the higher energies in many cases. The fission yield of Mo^{99} and the total fission cross section were evaluated as a function of He^4 ion energy. (auth)

827 RECOIL STUDY OF THE REACTION $C^{12}(p,pn)C^{11}$. Sarjant Singh and John M. Alexander (Univ. of California, Berkeley). Phys. Rev., 128: 711-19(Oct. 15, 1962). (UCRL-9911)

Recoil ranges of C^{11} from the reaction $C^{12}(p,pn)C^{11}$ are presented for incident proton energies from 0.25 to 6.2 Bev. From these data it is concluded that a neutron evaporation mechanism is probably not the major mechanism. The results are consistent with a fast reaction consisting of a single proton-neutron collision. Assuming this mechanism, an average kinetic energy of approximately 19 Mev can be deduced for the struck neutron (before the collision) in the C^{12} nucleus. (auth)

828 $Bi^{209}(d,p)Bi^{210}$ REACTION AT LOW BOMBARDING ENERGIES AND WITH HIGH RESOLUTION. J. R. Erskine, W. W. Buechner, and H. A. Enge (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 128: 720-8 (Oct. 15, 1962). (TID-16088)

The $Bi^{209}(d,p)Bi^{210}$ reaction has been studied with a multiple-gap magnetic spectrograph and an 8-Mev electro-

static accelerator. Forty energy levels were observed up to an excitation energy of 3.2 Mev. The ground-state Q value was measured to be 2.369 ± 0.010 Mev. The angular distribution of each group was peaked at an observation angle of 180 deg because of the large Coulomb barrier and relatively low bombarding energy, and the width of the backward peak depends weakly on the l value of the captured neutron. There is good agreement concerning the shape of the angular distribution between the experimental data and calculations using distorted-wave, deuteron-stripping theory. The ground-state group belongs to a cluster of nine groups, one of which is probably two unresolved groups. These nine groups probably correspond to levels in the Bi^{210} ground-state configuration ($h_{9/2}g_{9/2}$). The intensities of these groups appear to be proportional to the statistical factor (2J + 1). (auth)

829 COULOMB ENERGY OF He^3 AND CHARGE DISTRIBUTION OF NUCLEON. Haruko Ohmura and Takashi Ohmura (Washington Univ., St. Louis). Phys. Rev., 128: 729-33(Oct. 15, 1962).

The effect of finite nucleon size on the Coulomb energy of He^3 has been investigated. The experimental value of the difference between the binding energies of H^3 and He^3 is 0.764 Mev, while the calculated Coulomb energy is approximately equal to or greater than 1.0 Mev if the nuclear force has no repulsive core. It is shown that, if the finite size of the nucleon is taken into consideration, the Coulomb energy of He^3 is reduced by about 15–20%. The effect of finite charge distribution is determined mainly by the mean square radius. If there is a hard core (with radius D), the calculated Coulomb energy (assuming point nucleons) is already smaller, with the values 0.8–0.9 Mev for $D = 0.2 \times 10^{-13}$ cm, ~0.7 Mev for $D = 0.6 \times 10^{-13}$ cm. The reduction of Coulomb energy due to the finite size is about 8% and 3%, respectively, for two different models. The Coulomb potential between extended unpolarized nucleons is given in closed form for exponential and Yukawa charge distributions. (auth)

830 EFFECT OF THE OPTICAL POTENTIAL ON THE NUCLEON MOMENTUM DISTRIBUTION IN NUCLEI. THE PICKUP REACTION. Paul A. Benioff (Argonne National Lab., Ill.). Phys. Rev., 128: 740-50(Oct. 15, 1962). (TID-16266)

The effect of the optical potential on the nucleon momentum distribution in nuclei is discussed in this work. The idea of McCarthy et al., that the refraction and localization effects caused by the real and imaginary parts of the optical potential smears the single-particle momentum distribution, is amplified and applied to nucleon momentum distribution experiments. The assertion is made here that it seems impossible to directly measure in any manner the momentum distribution of nucleons in nuclei. Further it is proposed that much or all of the large discrepancy between the experimental momentum determinations and the shell-model predictions is due to the neglect of these important sources of high-momentum components. The high-energy $C^{12}(p,d)C^{11}$ pickup reaction data are re-analyzed in the light of these considerations. It is shown that for $q^2/\beta^2 \lesssim 8$, the 1 p-shell harmonic oscillator distribution, $(q^2/\beta^2)\exp(-q^2/\beta^2)$, has sufficient high-momentum components to fit the data. The lack of agreement for $q^2/\beta^2 > 8$ is possibly due more to a failure in the distorted-wave approximation calculation used here than to lack of high-momentum components in the wave function. (auth)

831 MAGNETIC MOMENTS OF THE FIRST EXCITED 2^+ STATES IN Sm^{152}, Gd^{154}, AND Gd^{156}. R. W. Bauer and M. Deutsch (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 128: 751-60(Oct. 15, 1962). (TID-15946)

The gyromagnetic ratios g of the 122-kev state of Sm^{152}, of the 123-kev state of Gd^{154}, and of the 89-kev state of Gd^{156} have been measured to be 0.35 ± 0.03, 0.367 ± 0.03, and 0.32 ± 0.03, respectively, by the precession of the angular correlation of gamma-ray cascades proceeding through these states in an external magnetic field. The perturbations of the angular correlations for sources both in aqueous solution and in molten anhydrous chlorides have been studied. The attenuation in a transverse magnetic field was used to determine the hyperfine structure constant of the 89-kev state of Gd^{156} in the $^8S_{7/2}$ ground state of Gd^{3+} in aqueous solution as a = 17 ± 3 Mc/sec. The perturbations in molten Gd sources were found to be much weaker than in solution and to be unaffected by magnetic fields. (auth)

832 ISOMERIC CROSS-SECTION RATIOS IN (n,γ) REACTIONS. M. L. Sehgal (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 128: 761-7(Oct. 15, 1962). (BNL-6135)

Isomeric cross-section ratios for (n,γ) reactions have been measured for the even-even target nuclei Te^{120}, Te^{130}, Ce^{138}, Pt^{196}, and Hg^{196}. In addition, cross sections for $Pt^{194}(n,\gamma)Pt^{195m}$ and $Pt^{192}(n,\gamma)Pt^{193m}$ reactions have also been measured. It is found that isomeric cross-section ratios ($\sigma_{\text{low spin}}/\sigma_{\text{high spin}}$) tend to increase at the magic numbers of neutrons as well as protons. Away from the magic numbers, these ratios obey an empirical rule which states, "The isomeric cross-section ratios for various isotopes in the same element remain approximately the same provided the spins of the compound nuclei and the isomeric states are the same for all the isotopes." This rule applies to even-even target nuclei. On the basis of this new empirical rule, the cross sections for the production of some of the isomeric states have been estimated. Multiplicity factors (i.e., the number of γ rays emitted per neutron capture by target nuclei) have been calculated for A < 100, using capture γ spectra of Groshev et al. Theoretical calculations of the isomeric cross-section ratios are performed using the spin dependence of the nuclear level density expression of Bloch. Experimental values of the isomeric cross-section ratios are compared with the theoretical values and the results are discussed. (auth)

833 TOTAL CROSS SECTIONS FOR FISSION OF U^{238} INDUCED BY He^4 AND HEAVY IONS. Victor E. Viola, Jr. and Torbjørn Sikkeland (Univ. of California, Berkeley). Phys. Rev., 128: 767-74(Oct. 15, 1962). (UCRL-10088)

The total fission cross sections have been measured for bombardment of U^{238} with He^4, B^{11}, C^{12}, N^{14}, O^{16}, and Ne^{20} ions at energies up to 10.4 Mev/nucleon. Because of the high fissionability of these systems, it is assumed that the fission cross section is equal to the total reaction cross section for heavy-ion reactions. The data have been compared with the theoretical cross-section calculations of Thomas, assuming (1) a square-well nuclear potential, and (2) a parabolic approximation to the real part of the optical potential. At energies well above the Coulomb barrier, the data are well represented using a square-well potential and $r_0 = 1.50F$. Near the barrier, however, the agreement is poor. With the parabolic approximation, the entire excitation function can be generally reproduced except in the case of Ne^{20}. For the He^4 data, these calculations used a well depth $V_0 = -67$ Mev, a nuclear radius $r_0 = 1.17F$, and a diffuseness parameter d = 0.574F. These values for heavy ions were $V_0 = -70$ Mev, $r_0 = 1.23$ to 1.26F, and d = 0.50 to 0.44F, r_0 increasing and d decreasing as a function of increasing heavy-ion mass. (auth)

834 FINITE NUCLEAR SIZE EFFECTS IN β DECAY. C. P. Bhalla (Westinghouse Electric Corp., Pittsburgh) and M. E. Rose. Phys. Rev., 128: 774-8(Oct. 15, 1962).

The finite nuclear size effects are of significant importance in the study of the second-order corrections to the allowed beta transitions, evaluation of nuclear matrix elements, and in all cases where the ξ approximation is not valid. Accurate electronic radial functions are computed by considering the finite nuclear size effects and the finite de Broglie wavelength effects. A summary of the computation procedure is given, and a comparison of the calculated beta-decay functions is made with the corresponding Coulomb functions. (auth)

835 $C^{14}(p,\alpha)B^{11}$ ANGULAR DISTRIBUTIONS AT E_p = 18 Mev. F. P. Brady and E. K. Warburton (Princeton Univ., N. J.). Phys. Rev., 128: 790-1(Oct. 15, 1962). (PUC-1962-76)

Angular distributions are given for the ground state and first three excited states of B^{11} following the $C^{14}(p,\alpha)B^{11}$ reaction at an incident proton energy of 18.0 Mev. The results suggest a direct-interaction reaction mechanism but are not in agreement with the simple plane-wave theory for this mechanism. (auth)

836 INELASTIC ELECTRON SCATTERING FROM V^{51}. H. W. Kendall and I. Talmi (Stanford Univ., Calif.). Phys. Rev., 128: 792-800(Oct. 15, 1962).

Shell-model predictions of the relative inelastic scattering cross section for excitation of the first four excited states of V^{51} are made using effective single-particle operators and the known configurations of these states. The predicted cross sections for excitation of three of these levels are compared with measured scattering cross sections determined at scattering angles less than 60° using electrons of primary energy 183, 300, and 600 Mev. (auth)

837 POLARIZATION OF PROTONS FROM DEUTERON STRIPPING REACTIONS WITH A ZERO ORBITAL ANGULAR MOMENTUM TRANSFER. A. Isoya and M. J. Marrone (Univ. of Pittsburgh). Phys. Rev., 128: 800-5 (Oct. 15, 1962).

Angular dependence of the polarization of protons from the l = 0 stripping reactions, $Al^{27}(d,p)Al^{28}_{g.s.,+1st}$ and $Si^{28}(d,p)Si^{29}_{g.s.}$, has been measured at a deuteron energy of 15 Mev. Polarization changes the sign at angles close to each minimum of the angular distribution, remaining the same in the angular region corresponding to each stripping peak. The magnitude of polarization is large (20 to 30%) near the angles at which the sign change takes place. (auth)

838 POLARIZATION OF PROTONS FROM DEUTERON STRIPPING REACTIONS WITH l = 1 ORBITAL ANGULAR MOMENTUM TRANSFER. A. Isoya, S. Micheletti, and L. Reber (Univ. of Pittsburgh). Phys. Rev., 128: 806-11(Oct. 15, 1962).

The angular dependence of the polarization of protons from (d,p) reactions with 15-Mev deuteron energy has been measured for several transitions associated with l = 1 neutron capture; $C^{12}(d,p)C^{13}_{g.s.}$, $Mg^{24}(d,p)Mg^{25}_{3.40\ Mev}$, $Ca^{40}(d,p)Ca^{41}_{1.95\ Mev}$, $Ca^{40}(d,p)Ca^{41}_{2.469\ Mev}$, and $V^{51}(d,p)V^{52}_{g.s.}$. The polarization patterns reveal some features characteristic of distortion polarization in the main stripping peak region; however, spin-orbit polarization seems to be predominant and to determine the general features of the angular dependence of the polarization. (auth)

839 SENIORITY MIXING IN $1f_{\frac{7}{2}}$ NUCLEI. R. D. Lawson and B. Zeidman (Argonne National Lab., Ill.). Phys. Rev., 128: 821-5(Oct. 15, 1962). (TID-16626)

The (d,t) experiments on nuclei in which the $1f_{\frac{7}{2}}$ shell is filling with neutrons and protons show several strong l = 3 peaks. This is interpreted as showing that the eigenfunctions describing nuclei in this region do not have well defined seniority. The Elliott generating procedure provides an alternative classification for the eigenfunctions and leads to states of mixed seniority. The strengths of the transitions calculated by use of these wave functions are generally in good agreement with experiment. (auth)

840 PARTIAL-WAVE ANALYSIS OF THE INELASTIC SCATTERING OF ELECTRONS BY NUCLEI. I. RESULTS FOR QUADRUPOLE EXCITATIONS. T. A. Griffy, D. S. Onley, J. T. Reynolds, and L. C. Biedenharn (Duke Univ., Durham, N. C.). Phys. Rev., 128: 833-40(Oct. 15, 1962).

The problem of nuclear Coulomb excitation by inelastic scattering is approached by using a distorted partial-wave description for the initial and final states of the electron and a multipole expansion of the interaction with the nucleus which is treated in the semiclassical approximation. The method is facilitated by use of a closed analytic form for the contribution to the scattering of partial waves of sufficiently high angular momenta to be insensitive to the shape (but not the charge) of the target nucleus. The contribution of partial waves which do penetrate the nuclear charge distribution is found by numerical evaluation of the various matrix elements using electron wave functions obtained by numerical solution of the radial part of the Dirac equation in a central field. The particular case of electric quadrupole excitation assuming a uniform charge distribution is calculated and compared with the usual Born approximation treatment of inelastic electron scattering. The results of the calculations for 200-Mev electrons differ from the Born approximation result in two ways: for scattering angles less than 90° the Coulomb field causes an apparent, and significant, change in the radius of the charge distribution; for scattering angles greater than 90° the cross section differs qualitatively from the Born approximation result. (auth)

841 COULOMB EFFECTS AND THE O^{14} β-DECAY MATRIX ELEMENT. Hans A. Weidenmueller (California Inst. of Tech., Pasadena). Phys. Rev., 128: 841-48 (Oct. 15, 1962).

The change of the Fermi matrix element of the β decay of O^{14} to the first excited state of N^{14} from its value $\sqrt{2}$ due to Coulomb corrections is reestimated. It is shown, that for pure 1 p-shell states the reduction is between 0.02 and 0.20%. Configuration mixing in the 1p shell may increase these figures considerably. Instead of arbitrary admixtures of higher configurations, a collective model for the presumably most important of such admixtures is considered: The model of a "breathing state" (radial density oscillation). It is shown that for sufficiently low values of the energy of the first excited breathing state compatible with experimental data for the level spectrum of the mass-14 system, the β-decay matrix element may be reduced by as much as five percent. In view of the lack of present knowledge about the breathing state and nuclear compressibility for light nuclei, it is concluded that the discrepancy between the measured values of the vector and μ-meson decay coupling constants of β decay may well be due to such an effect. (auth)

842 A FOKKER-PLANCK EQUATION FOR SPIN RELAXATION. A. Yoshimori and J. Korringa (Ohio State Univ., Columbus). Phys. Rev., 128: 1054-60(Nov. 1, 1962).

A method is developed to describe the quantum mechanical motion of a few simple spin systems, with random time-dependent perturbations, in an exact manner, i.e.,

without reference to perturbation theory. It leads to a Fokker-Planck type diffusion equation. When applied to a spin influenced by a fluctuating local field (Abragam's model), this gives rise to a (microscopic) Bloch-type equation for the spin operators. An application to a system of two identical spins ($S = \frac{1}{2}$) with modulated dipole interaction produces a very complicated diffusion equation in eight variables, which simplifies, however, in a case of restricted rotation. A model Hamiltonian for quadrupole relaxation for $S = 1$ gives a relatively simple result, which reveals an interesting difference between the relaxation in finite and zero external fields. (auth)

843 THEORY OF RELAXATION OF A TWO-SPIN SYSTEM. J. Korringa and A. Yoshimori (Ohio State Univ., Columbus). Phys. Rev., 128: 1060-9(Nov. 1, 1962).

The relaxation of a system of two inequivalent spins ($S = \frac{1}{2}$, $I = \frac{1}{2}$) with two noncommuting time-dependent interactions, i.e., a randomly modulated dipole interaction, and a fluctuating local field acting on one of the spins (S), is discussed. The influence of the fluctuating field is treated exactly in terms of a Fokker-Planck equation, which is described in the previous paper. The dipole interaction is then treated with perturbation theory. This gives, in all detail, the time-dependent transitions between the levels established in a constant external field. It is shown that rate equations are insufficient to describe the transitions, and that in weak fields a resonance phenomenon can occur. This resonance is studied in some detail with Green's function methods. (auth)

844 NUCLEAR QUADRUPOLE MOMENT OF Yb^{173}. John S. Ross (Rollins Coll., Winter Park, Fla. and Kiyoshi Murakawa (Tokyo Univ.). Phys. Rev., 128: 1159-60 (Nov. 1, 1962).

Using separated isotopes, the hyperfine structure of levels due to the configuration 6s6p of Yb I was measured. The quadrupole moment of Yb^{173} without shielding correction was found to be 3.1 ± 0.2 b. If the shielding correction factor for the configuration 6s6p is assumed to be -0.1, the quadrupole moment $Q(Yb^{173}) = 2.8 \pm 0.2$ b is obtained. This brings the spectroscopic value in agreement with the published Coulomb excitation result. (auth)

845 RECOILLESS NUCLEAR RESONANT ABSORPTION IN I^{129}. S. Jha, R. Segnan, and G. Lang (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 128: 1160-3 (Nov. 1, 1962).

Recoilless resonant absorption has been observed with the 26.8-kev gamma ray of I^{129} using the parent, Te^{129m}, as a source. With a ZnTe source and $NaI \cdot 2H_2O$ absorber the absorption spectrum has a structure which is interpreted in terms of quadrupole splitting in the absorber. The field gradient $q(1 - \gamma)$ at the iodine nucleus is experimentally found to be $-2.3a_0^{-3}$. The broader spectrum which is obtained with a Te metal source appears to contain many unresolved lines. It is interpreted as resulting from simultaneous quadrupole splitting in source and absorber. From the observed linewidth, the first-excited state of I^{129} is estimated to have a mean life of 1.5×10^{-8} sec. The small observed percentage effects result, at least in part, from dilution by x rays emitted by the source and the absorber. (auth)

846 DISTORTED WAVE CALCULATIONS OF (d,p) ANGULAR DISTRIBUTIONS. William R. Smith and Eugene V. Ivash (Univ. of Texas, Austin). Phys. Rev., 128: 1175-85(Nov. 1, 1962).

Deuteron stripping differential cross sections based on the distorted wave Born approximation with diffuse-well nuclear optical potentials have been calculated for a large number of reactions, using mainly a program whose average running time on a CDC 1604 computer is about 3 sec. In general, good agreement between theoretical and experimental results has been obtained for nuclei with $A \geq 59$ using nuclear parameters which are relatively constant. It has been found that best-fit elastic scattering optical parameters give good results for nuclei in this region. The effect of spin-orbit interactions on differential cross sections and on polarizations has also been examined. (auth)

847 PROPERTIES OF NUCLEAR LEVELS IN A NUMBER OF ODD-A NUCLEI ($151 \leq A \leq 191$). B. Harmatz (Oak Ridge National Lab., Tenn.), T. A. Handley, and J. W. Mihelich. Phys. Rev., 128: 1186-1230(Nov. 1, 1962).

In order to obtain more evidence on the systematic behavior of nuclear energy levels in the deformed region, a number of neutron-deficient odd-mass activities were studied with internal conversion electron spectrographs. Some scintillation counter measurements were made. Level schemes are postulated for decays leading to the following odd-neutron nuclei: $Pm^{151} \rightarrow Sm^{151}$, $Tb^{151} \rightarrow Gd^{151}$, $Tb^{153} \rightarrow Gd^{153}$, $Tb^{155} \rightarrow Gd^{155}$, $Eu^{157} \rightarrow Gd^{157}$, $Tm^{163} \rightarrow Er^{163}$, $Tm^{165} \rightarrow Er^{165}$, $Ho^{167} \rightarrow Er^{167}$, $Re^{183} \rightarrow W^{183}$, $Ir^{185} \rightarrow Os^{185}$, $Ir^{187} \rightarrow Os^{187}$, and $Ir^{189} \rightarrow Os^{189}$. As a corollary, data are presented for the odd-proton nuclei populated in the decays of $Pt^{189} \rightarrow Ir^{189}$ and $Pt^{191} \rightarrow Ir^{191}$. The proposed states are described using the Mottelson and Nilsson predictions. Some conclusions may be drawn concerning such properties of these orbitals as moments of inertia, M1/E2 mixing ratios, and positions of the intrinsic excitations. Ratios of gamma-ray transition probabilities from the various states are given. Previously published studies of odd-A nuclei in the region of odd-N numbers 99–107 are incorporated in the energy-level systematics. (auth)

848 NEUTRON INELASTIC SCATTERING FROM SOME COLLECTIVE NUCLEAR STATES. D. J. Donahue (Pennsylvania State Univ., University Park). Phys. Rev., 128: 1231-7(Nov. 1, 1962).

Fast neutrons from a reactor were used to produce, by inelastic scattering, excited states in various isotopes of Mg, Al, Ti, Cr, Fe, Cu, Zn, Mo, and Pb. The median energy of neutrons producing these excited states was approximately 2 to 3 Mev. Gamma rays emitted by the excited nuclei were observed with a NaI(Tl) crystal. After several corrections, the relative probabilities for exciting the various states by neutron inelastic scattering were obtained from the gamma-ray yields. A correlation is noted between the measured relative probability for exciting a nuclear state by neutron inelastic scattering and the reduced quadrupole transition probability, B(E2), of that state, obtained from Coulomb excitation experiments. (auth)

849 OPTICAL MODEL IN THE INTERIOR OF THE NUCLEUS. I. E. McCarthy (Univ. of Adelaide). Phys. Rev., 128: 1237-45(Nov. 1, 1962).

It is shown how phase relationships between partial waves in the optical model result in focusing effects which are largest for surface partial waves. In the case of very low incident energies where the wavelength of a partial wave is large compared to the nuclear surface thickness, it is shown how the phase relationships may enable surface- and volume-reaction mechanisms for a direct reaction to be distinguished by looking at gross features of the angular distribution. Thus, low-energy direct interactions may be used as a probe for the nuclear interior. (auth)

850 GAMMA RAYS FROM INELASTIC NEUTRON SCATTERING IN CHROMIUM. D. M. Van Patter, N. Nath,

S. M. Shafroth, S. S. Malik, and M. A. Rothman (Franklin Inst., Swarthmore, Penna.). Phys. Rev., 128: 1246-67 (Nov. 1, 1962).

Gamma-ray spectra from the $Cr(n,n'\gamma)$ reaction have been studied using a ring geometry for ten $Li^7(p,n)$ neutron energies ranging from 0.98 to 3.31 Mev. Isotopic assignments have been made for the observed gamma rays, and differential gamma-ray production cross sections have been obtained at $\bar{\theta} = 100°$. In order to convert these to inelastic neutron cross sections, calculations using Satchler's theory have been carried out for the angular distributions of the pertinent gamma transitions in Cr^{50}, Cr^{52}, and Cr^{54}. The resulting experimental (n,n') cross sections for individual levels have been compared to predictions using Hauser-Feshbach theory and various diffuse surface potentials. The use of the $(n,n'\gamma)$ reaction as a nuclear spectroscopic tool has proved to be of value, since new information has been found concerning the properties of some of the low-lying states of Cr^{52} and Cr^{53}. The relationship of these new results to other available experimental evidence and to current theoretical predictions is discussed in detail, particularly the possibility of appreciable fragmentation of the $2p_{\frac{3}{2}}$ and $2p_{\frac{1}{2}}$ single-particle states in Cr^{53}. The evidence for contributions of core excitation to Cr^{53} states is also considered. Finally, comparison of the total inelastic neutron cross section for Cr and each of its four stable isotopes has been made with theoretical predictions. (auth)

851 n-p DIFFERENTIAL SCATTERING CROSS SECTION AT 22.5 Mev. E. R. Flynn and P. J. Bendt (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 128: 1268-70(Nov. 1, 1962). (LADC-5092)

A tritium target was bombarded with 5-msec pulses of 6.1-Mev deuterons produced by the Los Alamos variable energy cyclotron. A collimated beam of 22.5-Mev neutrons from the $H^3(d,n)He^4$ reaction was directed into a 3.2-liter liquid-hydrogen bubble chamber. The resulting proton recoil tracks were photographed with 90° stereophotography. Film scanning, data reduction, and uncertainties in the measurements are described. The measurements cover neutron scattering angles from 60° to 180° in the c.m. system. The measured relative differential cross section in the c.m. system can be written $d\sigma/d\Omega = A_0 + A_2 \cos^2\theta$, where $A_2/A_0 = 0.113 \pm 0.03$. (auth)

852 DIFFERENTIAL ELASTIC SCATTERING OF 15.2-Mev NEUTRONS BY Ta, Bi, Th, AND U. Cecil I. Hudson, Jr., W. Scott Walker, and S. Berko (Univ. of Virginia, Charlottesville). Phys. Rev., 128: 1271-6 (Nov. 1, 1962). (UCRL-6875)

Angular distributions of 15.2-Mev neutrons elastically scattered by Ta, Bi, Th, and U have been measured using an associated particle time of flight system with an energy resolution of 1.8 Mev at 15.2 Mev (defined as the energy loss for which neutrons are detected with 50% efficiency relative to elastically scattered neutrons) and an angular resolution of ±2°. The data were corrected for multiple scattering and attenuation by Monte Carlo methods, and the results are compared with the theoretical optical model predictions of Bjorklund and Fernbach for spherical nuclei. For Ta, Th, and U, the diffraction pattern appears damped in the backward angles, an effect attributable to the large deformations present in these nuclei. (auth)

853 CROSS SECTIONS FOR CHARGED PARTICLE REACTIONS INDUCED IN MEDIUM WEIGHT NUCLEI BY NEUTRONS IN THE ENERGY RANGE 12–18 Mev. F. Gabbard and B. D. Kern (Univ. of Kentucky, Lexington). Phys. Rev., 128: 1276-81(Nov. 1, 1962).

Data are presented for (n,p) cross sections in Mg^{24}, Al^{27}, Ti^{48}, and Zn^{64}; and (n,α) reactions in Al^{27}, P^{31}, Mn^{55}, and Co^{59}. The neutron energy range was from 12 to 18 Mev. The experimental results are compared with statistical model calculations using an energy dependence of the level density of the form $\exp[2(aE^*)^{\frac{1}{2}}]$. Results of this comparison show that with the proper choice of the level-density and pairing-energy parameters the statistical model theory gives total (n,p) and (n,α) cross-section values in fair agreement with the experimental data. However, some of the parameters show marked deviations from expected trends. (auth)

854 EXCITATION FUNCTIONS OF SOME REACTIONS OF 6- TO 24-Mev He^3 IONS WITH CARBON AND ALUMINUM. D. R. F. Cochran and J. D. Knight (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 128: 1281-6(Nov. 1, 1962). (LADC-5382)

Excitation functions of the reactions $C^{12}(He^3,\alpha)C^{11}$, $C^{12}(He^3,pn)N^{13}$, $C^{12}(He^3,2\alpha)Be^7$, $Al^{27}(He^3,\alpha 2p)Na^{24}$, $Al^{27}(He^3,2\alpha)Na^{22}$, and $Al^{27}(He^3,3\alpha)F^{18}$ have been measured for He^3 energies from 6 to 24 Mev by the stacked-foil technique. The cross section for production of C^{11} reaches a maximum of 340 mb at 8.9 Mev, with smaller maxima at 10.6 and 15.5 Mev. The cross section for N^{13} reaches a broad maximum of 140 mb in the vicinity of 14 Mev, with evidence of a secondary maximum at 10.9 Mev. The cross section for Be^7, measured with somewhat poorer resolution, reaches a broad maximum of about 100 mb in the vicinity of 17.5 Mev. The cross section for production of Be^7 by 24-Mev He^3 bombardment of aluminum is about 0.1 mb. (auth)

855 SPIN ASSIGNMENTS OF LOW-ENERGY RESONANCES USING POLARIZED NEUTRONS AND POLARIZED Sm^{149} NUCLEI. H. Marshak, Hans Postma, V. L. Sailor, F. J. Shore, and C. A. Reynolds (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 128: 1287-96 (Nov. 1, 1962). (BNL-6191)

The spins of the four resonances at 0.0976, 0.87, 4.93, and 8.9 ev in Sm^{149} have been measured by using a monoenergetic polarized neutron beam incident on polarized samarium nuclei. By using one stage of adiabatic demagnetization, polycrystalline samples of samarium ethyl sulfate and samarium double nitrate were cooled to approximately 0.15°K. At this temperature and with the aid of an external magnetic field an appreciable polarization of the samarium nuclei is achieved by making use of the hfs coupling (Rose-Gorter method). The spin assignments for the above four resonances were all $J = I + \frac{1}{2} = 4$. The samarium nuclei in the double nitrate sample were found to be polarized in the same direction as in the ethyl sulfate sample. Measurements made on samarium metal at these low temperatures indicate that it is antiferromagnetic. (auth)

856 ELECTRON CAPTURE AND NUCLEAR MATRIX ELEMENTS OF Be^7. John N. Bahcall (Indiana Univ., Bloomington). Phys. Rev., 128: 1297-1301(Nov. 1, 1962).

The Be^7 electron capture rate from continuum orbits is calculated as a function of electron temperature and concentration, and the effect on the decay rate of the statistical distribution of electrons, the electron-nucleus Coulomb interaction, relativistic and nuclear size corrections, the imperfect overlap between initial and final atomic states, and electron screening in bound decay, is considered. Experimental information on Be^7 and Li^7 is analyzed to obtain accurate experimental Gamow-Teller matrix elements for both the ground- and excited-state transitions and compare these matrix elements with the predictions of some simple

nuclear models. This comparison supports the conclusion that near the beginning of the 1p nuclear shell L-S coupling is better satisfied than j-j coupling. (auth)

857 NUCLEAR STRUCTURE STUDIES IN THE 82-NEUTRON REGION WITH STRIPPING REACTIONS. R. H. Fulmer, A. L. McCarthy, and B. L. Cohen (Univ. of Pittsburgh). Phys. Rev., 128: 1302-11(Nov. 1, 1962).

The energies of single-particle states in the $82 < N \leq 126$ shell are determined by (d,p) reactions on the 82-neutron isotones Ce^{140} and Ba^{138}. The results are: $f_{5/2}-0$; $p_{3/2}-0.83$ Mev; $f_{7/2}-1.88$ Mev; $h_{9/2}-1.9$ Mev; $p_{1/2}-2.25$ Mev. The energies of the single-hole states in the $50 < N \leq 82$ shell are determined by (d,t) reactions on these nuclei. The results are $d_{5/2}-0$; $s_{1/2}-0.27$ Mev; $h_{11/2}-0.71$ Mev; $g_{7/2}-1.37$ Mev; $d_{3/2}-\approx 2.3$ Mev. There is good agreement between determinations from the two nuclei, and the slight differences are averaged in the above results. The level structure of the 81 and 83 neutron isotopes of Pr are similar to those of Ba and Ce; the splitting due to different couplings with the odd proton are small, and there is little evidence for mixing among the low-lying states. New levels are located in various isotopes of Ba, Ce, Pr, and Nd. The $d_{5/2}-s_{1/2}$ splitting in 81-neutron nuclei is measured and discussed. Information is obtained on the shell-model wave functions for the ground states of the two-hole nucleus Ba^{136} and the two-particle nuclei Ce^{142} and Nd^{144}. (auth)

858 STUDY OF THE REACTION $Ne^{20}(\alpha,\alpha'\gamma)Ne^{20}$. W. W. Eidson and R. D. Bent (Indiana Univ., Bloomington). Phys. Rev., 128: 1312-20(Nov. 1, 1962).

Particle-gamma coincidence spectra of the reaction $Ne^{20}(\alpha,\alpha'\gamma)Ne^{20}$ provide evidence for the existence of two, new, gamma-emitting levels in Ne^{20}. A new level at 7.93 Mev is observed to decay by gamma emission to the 4.97-Mev (2^-) level; a new level at 5.88 Mev is observed to decay to the 4.25-Mev (4^+) level. Tentative spin-parity assignments are 3^+ for the 5.88-Mev level and 1^+, 2^-, 3^+, or 4^- for the 7.93-Mev level. Evidence is seen for the recently discovered level at 7.02 Mev (4^-). The data suggest a considerably larger value of $\Gamma\gamma/\Gamma$ for the 5.63-Mev (3^-) level than that previously reported. Angular distribution measurements of elastic and inelastic alpha-particle groups are compared with current direct-interaction theory. The production of states of Ne^{20} with $J \neq L$ through inelastic alpha-particle scattering suggests a fairly strong spin-orbit interaction between the orbital angular momentum of the incident alpha particle and the spin of one (or more) target nucleons. Possible collective model interpretations of the Ne^{20} level structure are suggested. (auth)

859 (p,α) REACTIONS IN Li^7, Be^9, AND C^{12} AT 15.0–18.6 Mev. Donald R. Maxson (Princeton Univ., N. J.). Phys. Rev., 128: 1321-8(Nov. 1, 1962). (PUC-1962-70)

Angular distributions of alpha particles from the $Li^7(p,\alpha)He^4$ reaction were measured at bombarding energies of 15.0 and 18.6 Mev, and $Be^9(p,\alpha)Li^6$ and $C^{12}(p,\alpha)B^9$ angular distributions were each measured at 15.6 and 18.6 Mev. Absolute cross sections were measured for all of the reactions. The main features of the $Li^7(p,\alpha)He^4$ angular distributions, which are symmetric about 90 deg, can be reproduced by the appropriately symmetrized triton pickup theory. The $Be^9(p,\alpha)Li^6$ ground state and $Be^9(p,\alpha)Li^{6*}$ (2.2 Mev) reactions exhibit backward peaking which suggests a possible contribution from heavy particle stripping. The $C^{12}(p,\alpha)B^9$ angular distributions are oscillatory but cannot be fitted satisfactorily using the plane wave triton pickup or knock-on theories. The oscillations in the $Li^7(p,\alpha)He^4$ and $C^{12}(p,\alpha)B^9$ angular distributions do not shift in angle as the bombarding energy is changed, so that the value used for the interaction radius must be decreased as the proton energy is raised. None of the angular distributions are strongly energy dependent, and all of the cross sections decrease with increasing bombarding energy. (auth)

860 NEUTRONS FROM DEUTERON BREAKUP ON D, T, AND He^4. H. W. Lefevre, R. R. Borchers, and C. H. Poppe (Univ. of Wisconsin, Madison). Phys. Rev., 128: 1328-35(Nov. 1, 1962). (TID-15926)

The continuous neutron spectra produced by deuteron bombardment of D, T, and He^4 have been studied at deuteron energies near 9 Mev with a time-of-flight spectrometer. Angular distributions of the continuous spectra from D + d and He^4 + d were obtained for deuteron energies of 9 and 10 Mev. The center-of-mass angular distributions are peaked forward for neutrons of all energies. Two maxima present in the 0° spectrum from He^4 + d at E_d = 10 Mev are consistent with the interpretation that He^5 and Li^5 are produced in their ground states as alternative intermediate steps in the reaction. Two maxima are also present in the continuous neutron spectrum from T + d. The higher energy maximum occurs near the maximum possible neutron energy from the T(d,np)T reaction and cannot be caused by the T(d,2n)He^3 reaction. If this peak is caused by an excited state in He^4, it would correspond to an excitation in He^4 of 20.0 ± 0.2 Mev, and be unbound. (auth)

861 VIRTUAL STATE OF THE α PARTICLE. Carl Werntz (Univ. of Wisconsin, Madison). Phys. Rev., 128: 1336-41(Nov. 1, 1962). (TID-14686)

The spectrum of neutrons produced in the forward direction from the breakup reaction T(d,pn)T shows a pronounced peak at its high-energy end. Using standard techniques for calculating the energy dependence of cross sections for reactions leading to three-body final states, this peak is analyzed in terms of an α-particle resonance slightly above threshold for the unbound T-p system. Reasons are given for believing the virtual state to be 0^+ with T = 0. (auth)

862 INELASTIC ELECTRON SCATTERING FROM Be^9 AND C^{12}. P. D. Kunz (Univ. of British Columbia, Vancouver). Phys. Rev., 128: 1343-51(Nov. 1, 1962).

High-energy inelastic electron scattering data for the first excited states in Be^9 and C^{12} are analyzed from the standpoint of three nuclear models, the alpha-particle model, the Nilsson model, and the spherical shell model. It is found that the spherical shell model with an enhancement of the quadrupole charge distribution by a factor of 2 gives a good fit to the inelastic data as a function of the momentum transfer. The alpha-particle model and Nilsson models, although correctly giving the magnitude of the low momentum transfer data, fail to predict the high momentum transfer data. These models can be used to determine closely the size of the low-energy properties of these nuclei such as the quadrupole moments and gamma-ray lifetimes. (auth)

863 NUCLEAR SPINS, HYPERFINE STRUCTURES, AND NUCLEAR MOMENTS OF SCANDIUM-46 AND YTTRIUM-91. F. Russell Petersen and Howard A. Shugart (Univ. of California, Berkeley). Phys. Rev., 128: 1740-6 (Nov. 15, 1962). (UCRL-10169)

The atomic-beam magnetic-resonance method has been used to study some atomic and nuclear properties of 84-day Sc^{46} and 58-day Y^{91}. The results are

		$^2D_{5/2}$ (Mc/sec)	$^2D_{3/2}$ (Mc/sec)
Sc^{46}	I = 4	g_J = −0.7990(8)	g_J = −1.1995(18)
	$(\mu_I)_{uncorr}$ = +3.03(2) nm	a = +150.576(9)	a = +60.906(4)
	Q_{uncorr} = +0.11(6) b	b = +14.38(14)	b = +20.41(10)
Y^{91}	I = 1/2	a = ±68.34(2)	a = ±34.35(3)
	$(\mu_I)_{uncorr}$ = +0.1634(8) nm	$\Delta\nu$ = ±136.69(3)	$\Delta\nu$ = ±103.05(4)

(auth)

864 BETA-GAMMA EMISSION THROUGH VIRTUAL STATES. M. E. Rose (Univ. of Virginia, Charlottesville), R. Perrin, and L. L. Foldy. Phys. Rev., 128: 1776-8 (Nov. 15, 1962).

The possibility of observing a combined beta-gamma transition through a virtual intermediate nuclear state in competition with a direct forbidden beta decay is investigated. Such a transition is coherent with ordinary inner bremsstrahlung associated with the direct transition and can therefore be observed through the distortion of the gamma-ray spectrum from the form predicted for inner bremsstrahlung alone. Favorable circumstances occur particularly when the intermediate state of the daughter nucleus is nearly degenerate with the ground state of the parent. The K-capture transition in Ni^{59} appears to offer the best possibility for such an observation. The direct observation of negative-helicity gamma rays with appropriate spectrum would be another way of directly establishing the alternate decay mode. (auth)

865 DECAY OF At^{212}; THE $Bi^{209}(\alpha,n)At^{212}$ REACTION. J. C. Ritter and W. G. Smith (Purdue Univ., Lafayette, Ind.). Phys. Rev., 128: 1778-82(Nov. 15, 1962). (TID-16279)

At^{212} was produced by the $Bi^{209}(\alpha,n)At^{212}$ reaction by bombarding Bi^{209} with a beam of 19-Mev helium ions from the Purdue cyclotron. The At^{212} was observed to decay by alpha emission with a half life of 0.20 ± 0.04 sec. The kinetic energy of the alpha particles emitted in the decay was measured using Au-Si surface-barrier charged particle spectrometers. The alpha-decay energy was found to be 7.87 ± 0.07 Mev. The relative excitation function of the $Bi^{209}(\alpha,n)At^{212}$ reaction was also obtained in the center-of-mass energy range from 17.87 to 18.86 Mev. The hindrance factor for the At^{212} decay is calculated using the experimentally measured At^{212} alpha-decay energy. (auth)

866 NUCLEAR MATRIX ELEMENTS IN THE FIRST-FORBIDDEN BETA DECAY OF THE Eu^{152} GROUND STATE. P. Alexander and R. M. Steffen (Purdue Univ., Lafayette, Ind.). Phys. Rev., 128: 1783-8(Nov. 15, 1962). (TID-16170)

The degree of circular polarization $P_c(\theta_{\beta\gamma})$ and the directional correlation $W(\theta_{\beta\gamma}) = 1 + A_2(W)P_2(\cos\theta_{\beta\gamma})$ were measured in the 3^-(1.49-Mev β^-) → 2^+(0.344-Mev γ) → $0^+\beta$-γ cascade leading from the ground state of Eu^{152} to the Sm^{152} ground state. The angle $\theta_{\beta\gamma}$ is the angle between the β and γ momentum vectors. Representative values of $P_c(\theta_{\beta\gamma})$ measured at $\bar{W}$ = 3.20 (in units mc^2) for some average angles $\bar{\theta}_{\beta\gamma}$ are: $P_c(90°) = -0.01 \pm 0.09$, $P_c(130°) = +0.33 \pm 0.07$, $P_c(157°) = 0.33 \pm 0.07$, $P_c(171°) = 0.24 \pm 0.10$. Some representative values of the directional correlation coefficient $A_2(W)$ are: $A_2(2.8) = -0.335 \pm 0.006$, $A_2(3.15) = -0.363 \pm 0.006$, $A_2(3.4) = -0.381 \pm 0.005$, $A_2(3.7) = -0.388 \pm 0.004$. The data were analyzed on an electronic digital computer on the basis of the Kotani parameters Y, u, x, and z. Information obtained about the nuclear matrix parameters may be summarized as follows: $Y = 0.70 \pm 0.20$, $x = 0.125 \pm 0.06$, $u = 0.125 \pm 0.06$, $z = 1.0$. Taken jointly with the ft value of the 1.49-Mev β transition these parameters yield the nuclear matrix elements: $\int B_{ij}/R = \pm(2.9 \pm 0.4) \times 10^{-3}$, $\int r/R = \pm(4.3 \pm 2.3) \times 10^{-4}$, $\int i\sigma \times r/R = \pm(3.6 \pm 1.9) \times 10^{-4}$, $\int i\sigma = \pm(2.5 \pm 1.1) \times 10^{-4}$, where R is the nuclear radius of Eu^{152} in units of $\hbar/mc$. These results reveal the importance of $\int B_{ij}$ relative to the other nuclear matrix elements which contribute to the decay. The experimental value of the matrix element ratio $\int i\sigma / \int r$ agrees with the prediction of the conserved vector current theory of beta decay. (auth)

867 SEARCH FOR H^5. Robert J. Cence and Charles N. Waddell (Univ. of California, Berkeley). Phys. Rev., 128: 1788-90(Nov. 15, 1962). (UCRL-10060)

Following the suggestion that H^5 might be stable against nucleon emission, a search was made for delayed neutrons resulting from the reaction $Li^7(\gamma,2p)H^5$. The targets were bombarded with a 340-Mev bremsstrahlung beam and the delayed neutrons detected in a shielded paraffin-moderated array of BF_3 counters. Counts were scaled in 14 delay channels of variable width and variable initial delay. Separated isotopes of Li^7 and Li^6 were used as targets. As H^5 cannot be produced from the bombardment of Li^6, counts observed during the bombardment of Li^6 were used to measure the background. After background subtraction, the data fall uniformly about zero and show no apparent lifetime. Assuming a 10-msec half-life, an upper limit for the activation cross section is $\sigma_A \leq 3 \times 10^{-32}$ cm^2. A comparison of this with the yield expected from the extrapolation of the measured yields of the reactions $B^{11}(\gamma,2p)Li^9$ and $F^{19}(\gamma,2p)N^{17}$ indicates that the upper limit for the activation cross section is of the order of 1% of the expected yield. Hence it appears unlikely that H^5 is stable against particle emission. (auth)

868 MONTE CARLO CALCULATIONS OF THE GROUND STATE OF THREE- AND FOUR-BODY NUCLEI. M. H. Kalos (United Nuclear Corp., White Plains, N. Y.). Phys. Rev., 128: 1791-5(Nov. 15, 1962).

By means of a suitable Green's function, the Schrödinger equation for the few-body nuclear problem is written as an integral equation. In this equation, the binding energy of the ground state is assumed known and the strength of potential required to give this energy is an eigenvalue to be determined. A random walk can be devised whose collision density satisfies the same integral equation. The simulation of this random walk therefore permits an exact numerical solution by Monte Carlo methods. The calculation has been carried out with pairwise potentials of square, Gauss, and exponential shape. (auth)

869 STUDY OF 83-NEUTRON NUCLEI BY DEUTERON STRIPPING REACTIONS. F. W. Bingham and M. B. Sampson (Indiana Univ., Bloomington). Phys. Rev., 128: 1796-?(Nov. 15, 1962).

A study of the 83-neutron nuclei Ba^{138}, La^{139}, and Pr^{141} was made by the (d,p) stripping reaction with 11-Mev deuterons. The outgoing protons were analyzed with a magnetic spectrometer, and angular distributions were measured for the well-resolved states. Excited levels, with spins and parities indicated in parentheses, were found at 0 ($^7/_2$-), 0.59 ($^3/_2$-), 1.07, 1.39, 1.67 ($^5/_2$-), 1.20 ($^1/_2$-), 2.44 ($^1/_2$-) Mev in Ba^{139}; at 0 ($g_{9/2}$ $f_{5/2}$), 0.25 ($g_{9/2}$ $f_{7/2}$), 0.60 ($g_{9/2}$ $p_{3/2}$), 0.71 ($g_{9/2}$ $p_{1/2}$), 1.02, 1.31, 1.37, 1.46, 1.80, 1.88, 1.95, and 2.13 Mev in La^{140} ($d_{5/2}$ $f_{5/2}$), 0.62 ($d_{5/2}$ $p_{3/2}$), 1.02 ($d_{5/2}$ $p_{1/2}$), 1.38 ($d_{5/2}$ $p_{3/2}$), and 2.12 Mev in Pr^{142}. The angular distributions were fitted with a distorted-wave Born approximation calculation to determine the angular momentum transfer. The absolute Q values obtained agree with previous measurements. A comparison is made with earlier measurements on the 83-neutron nucleus Ce^{141}. (auth)

870 HIGH-ENERGY GAMMA RAYS AND LOW-ENERGY PROTONS AND DEUTERONS FROM C^{12} + p FOR

E_p = 14-20 Mev. E. K. Warburton and H. O. Funsten (Princeton Univ., N. J.). Phys. Rev., 128: 1810-19 (Nov. 15, 1962). (PUC-1962-82)

The 90° yield of gamma rays from proton bombardment of C^{12} was studied for proton energies between 14 and 20 Mev. Gamma rays are observed corresponding to the ground-state decay of the C^{12} 4.43-, 12.7-, and 15.1-Mev levels and from the $C^{12}(p,\gamma_0)N^{13}$ reaction. Three resonances are observed in the yield of the 15.1-Mev gamma ray. These resonances correspond to N^{13} levels at 18.1, 18.65, and 19.8 Mev. The N^{13} 18.1-Mev level has a width of 330 ± 100 kev in the center-of-mass system. The other two levels have widths less than 200 kev. The yields of the 4.43- and 12.7-Mev gamma rays reveal little or no structure. The excitation function of the $C^{12}(p,\gamma_0)N^{13}$ reaction also shows little structure. Angular distributions and absolute integrated cross sections for the $C^{12}(p,p')C^{12}$ reaction are given for the C^{12} 12.7-Mev level with E_p = 17.5, 19.5, and 20 Mev and for the C^{12} 15.1-Mev level with E_p = 19.5 Mev. The latter is approximately symmetrical about 90° which suggests possible contribution from the compound nucleus reaction mechanism. Comparison of the cross sections for $C^{12}(p,p'\gamma)C^{12}$ and $C^{12}(p,p')C^{12}$ gives $\Gamma_\gamma/\Gamma = 0.027 \pm 0.007$ for the C^{12} 12.7-Mev state and 1.15 ± 0.3 for the C^{12} 15.1-Mev state. The yield of the $C^{12}(p,d)C^{11}$ reaction was measured by the stacked foil technique from threshold (E_p = 17.85 Mev) to 19.8 Mev. There is no evidence for structure. Angular distributions are given for the $C^{12}(p,d)C^{11}$ reaction for E_p = 19.3, 19.5, and 20.0 Mev. The results are compared to previous work on the $B^{11}(d,n)C^{12}$ reaction and it is concluded that the contribution of the compound nucleus reaction mechanism to either reaction is most likely small for the bombarding energies in question. (auth)

871 SIMPLE NUCLEAR REACTIONS OF INDIUM WITH 30- AND 2.9-Gev PROTONS. Norbert T. Porile (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 128: 1916-20(Nov. 15, 1962). (BNL-6230)

Cross sections have been measured for the following reactions of indium with 30 and 2.9 Bev protons: (p,p'), $(p,p\pi^+)$, and (p,pxn) (x = 1, 2, 4-6). The cross sections were measured as a function of target thickness and the results corrected for production by secondaries. The cross sections for the $(p,p\pi^+)$ reaction are 0.12 and 0.18 mb at 30 and 2.9 Bev, respectively. For each of the other reactions the cross section at 30 Bev is approximately the same as that at 2.9 Bev. Upper limits of 6 and 0.3 μb were obtained for the $(p,p2\pi^+)$ reaction cross section at 2.9 and 30 Bev, respectively. The cross sections for the $(p,p\pi^+)$ reaction are in agreement with theoretical estimates. (auth)

872 THE EXPERIMENTAL DETERMINATION OF THE CORRECTION FACTORS k(t) FOR THE FAST FISSION FACTORS MEASUREMENTS. E. Erdik (Univ. of Ankara). Rev. fac. sci. univ. Istanbul Ser. C., 27: 16-25 (Jan. 1962). (In English)

The determination of conversion factors k(t), as functions of the time after end of exposure, to convert a measured ratio of U^{238}/U^{235} fission-product β activities to a true fission rate ratio is carried out by the double-fission-chamber method. The ratio of U^{238}/U^{235} fission-product β activities can be taken in place of the fission rate ratio using on the average a 60-min waiting time after the end of the exposure and a 10-min counting time. Under these circumstances, the average value of the conversion factor k(t) is found to be equal to unity. (auth)

873 THE ENERGY DISTRIBUTION OF FAST PHOTONEUTRONS FROM LEAD. Hans Breuer (Max-Planck-Institut für Biophysik, Frankfurt am Main). Z. Naturforsch., 17a: 584-90(July 1962). (In German)

The spectrum of photoneutrons emitted under 90° from Pb was measured with a LiI spectrometer. The spectrum is composed of two parts. The largest part (approximately 89% of all the neutrons emitted) originates from an emission which can be described with the Weisskopf evaporation theory and shows a Maxwell distribution with a maximum at 0.9 Mev. Fifteen per cent of all neutrons can be explained by a so-called "direct" nuclear photoeffect and follow an energy distribution with a maximum between 4 and 5 Mev. (tr-auth)

874 DIRECT PAIR PRODUCTION BY 800 Mev ELECTRONS. Bernard Merril Chasan. Thesis, Ithaca, N. Y., Cornell Univ., 1961. 63p.

The cross section for electron-positron pair production by 800-Mev electrons is measured in an argon-filled diffusion cloud chamber. The chamber is mounted in a magnetic field of 6000 gauss. Electrons follow curved tracks in the chamber, and are thus separated from the trajectories followed by gamma rays. This expedient cuts down to a few percent the pseudotrident correction resulting from materialization of gamma-produced pairs on electron tracks. The primary electrons are produced in a copper converter by a bremsstrahlung beam, and are directed into the chamber by a system of two bending magnets. An average of about 20 electrons per picture is obtained. About 53,000 pictures are taken and scanned; 47 apparent tridents are found. However, it is felt that pairs having very low energy members could be missed because of some gappiness in the chamber. For this reason, and in order to make the experimental cross section a well-defined quantity, an integrated cross section for pair energies greater than or equal to 8 Mev is inferred from the data, rather than a total cross section. The result is: σ (E pair > 8 Mev) = $(0.51 \pm 0.09) \times 10^{-25}$ cm²/atom. Comparison may be made with theoretical calculations. Calculations are subject to some uncertainty; in particular, the integrated cross section depends on a parameter α, which comes into the calculation as a detail of an approximation used to evaluate the basic theory. However, it is estimated theoretically that $\alpha \approx 1$, and the experimental result is consistent with this value. Thus, this measurement does not confirm the conjecture that the direct pair cross section is anomalously large. Despite the small number of events, the differential properties of the direct pair process are studied. It is found that both the energy distribution of created pairs and the energy sharing between the members of created pairs are consistent with calculated values. (Dissertation Abstr., 22: No. 7, 1962.)

875 PAIR AND TRIPLET PRODUCTION BY 90 Mev BREMSSTRAHLUNG IN ILFORD G-5 EMULSION. Harbhajan Singh Sandhu. Thesis, University Park, Pennsylvania State Univ., 1961. 94p.

The pair, triplet, and multiplet creation processes produced by 90-Mev bremsstrahlung in Ilford G-5 nuclear emulsion are studied. The photon beam is hardened by introducing 496.43 g/cm² of carbon in the beam path in order to reduce the intensity of compton and photo-electrons and thus increase the signal/noise ratio for convenient identification and measurement of pair-electron tracks. The nuclear emulsions, of 400μ thickness, are processed by the temperature-development method, and a Leitz orthoolux microscope with 100X objective and 16X eyepiece is used to study the events. The energy determination is accomplished by the multiple scattering technique for high energy electrons and by the range-energy method for low energy ones. The theoretical pair cross sections for G-5

nuclear emulsion are computed from cross section values, taking into account the weighted contributions from the various elements constituting the emulsion. This information is used to calculate the incident bremsstrahlung spectrum from the experimental distribution-in-energy of 5739 electron pairs. This bremsstrahlung spectrum is used to calculate the triplet cross sections from the triplet data. The relative total cross sections for triplet production and pair + triplet production processes are found to be in agreement with theories. The energy partition between the positrons and electrons at various photon energies is compared with the Bethe-Heitler theory for pairs and with differential cross section functions for triplets. In general, the experimental distributions are more peaked for equipartition and have fewer electrons for extremely unequal partition of energy than predicted by the theory. The pair/triplet ratios are calculated in 8-Mev intervals from 2 to 90 Mev. These ratios are more or less constant within the statistical accuracy. The overall pair/triplet ratio is 11.3 ± 0.2. In all, 106 quartets are identified and their energy distribution is studied. The number of quartets is too small to admit any conclusive results concerning the total cross sections of quartet production. The pair/quartet ratio is found to be 206, which points to the conclusion that the quartet production cannot be considered to be a double pair-creation process. In addition to triplets and quartets, ten quintets and one sextet are also observed. In triplets, as well as in other higher order processes, there are always two high energy tracks, and the rest of the tracks are low energy ones. (Dissertation Abstr., 22: No. 7, 1962.)

876 ANGULAR DISTRIBUTIONS OF ALPHA PARTICLES AND PROTONS FROM THE REACTIONS $N^{14}(\alpha,\alpha)N^{14}$, $Na^{23}(\alpha,p)Mg^{26}$, $Al^{27}(\alpha,p)Si^{30}$ AND $Si^{28}(\alpha,p)P^{31}$ AT 19 Mev. William Dale Ploughe. Thesis, Lafayette, Ind., Purdue Univ., 1961. 158p.

A focused and energy-analyzed 19-Mev alpha-particle beam is used to bombard the targets. The elastically and inelastically scattered alpha particles from the gaseous N^{14} target are detected by means of nuclear photographic plates spaced every 2.5° in a multiplate scattering chamber covering the laboratory angular range of 10 to 170°. The reaction protons from the Na^{23}, Al^{27}, and Si^{28} targets are detected in a CsI (Tl) scintillation spectrometer and recorded in a twenty-channel pulse-height analyzer. The protons are identified by absorbing or degrading the energy of all shorter-range reaction products before they strike the CsI (Tl) crystal. The elastic angular distributions of alpha particles from N^{14} exhibit a diffraction-like pattern, similar to that observed on other light nuclei, in the forward direction, but this pattern becomes smeared out in the backward direction. The cross section deviates strongly from pure Coulomb scattering, rising more than a factor of 225 above the Rutherford cross section in the backward direction. The forward part of the elastic angular distribution is fitted with a diffraction model using an interaction radius of 5.89×10^{-13} cm. The angular distribution for the Q = −3.95 Mev group is fitted using an interaction radius of 5.9×10^{-13} cm. With the same interaction radius, a best fit to the data for the unresolved Q = −4.91 and −5.10 Mev doublets is obtained. This best fit by odd-order spherical Bessel functions is consistent with the assignment of negative parity to both the 4.91- and 5.10-Mev levels. The proton angular distributions for all three targets exhibit diffraction-like patterns and are peaked in the forward direction. Assuming that the reaction proceeds by the knock-out process, the angular distributions are fitted to several models. From the normalizing constant a factor is extracted, which contains nuclear information concerning the interaction potential and the reduced widths. The angular distributions are also integrated to give total cross sections. For the Si^{28} reaction an incoherent heavy-particle stripping term is added to the cross section for the knock-out process to obtain better fits at large angles. The cross sections to the ground states of the final nuclei increase through the series F^{19}, Na^{23}, and Al^{27}. The large cross section to the P^{31} ground state can be interpreted as the knock-out of an $s_{\frac{1}{2}}$ proton from Si^{28}, in contrast to the usual picture of a $d_{\frac{5}{2}}$ closed shell of Si^{28} and the capture of an $l = 0$ alpha particle or as the capture of an $l = 0$ triton in an alpha-particle stripping process. Comparison of the total cross sections shows that the sodium-minus-proton core in the $Na^{23}(\alpha,p)Mg^{26}$ is more common to the first excited state of Mg^{26} than to the ground state. In the case of the $Al^{27}(\alpha,p)Si^{30}$ reaction the transferred core is more common to the ground state, as is the case in the $Si^{28}(\alpha,p)P^{31}$ reaction. (Dissertation Abstr., 22: No. 7, 1962.)

877 INVESTIGATIONS ON ANGULAR CORRELATION AND EXCITED STATES OF FISSION FRAGMENTS. Lovlesh Rai Khare. Thesis, University Park, Penna., Pennsylvania State Univ., 1961. 68p.

Angular correlations between fission fragments and associated gamma rays emitted with half lives up to microseconds from thermal neutron fission of U^{235} are investigated, and the possible excited states of the fragments that emit these gamma rays are looked for. It is questioned whether there is only one fission fragment corresponding to the particular gamma energy chosen, in which case, the experiment could lead to direct evidence of the excited levels of that fragment. A gridded double ionization chamber is used for the measurements, utilizing an electronic technique capable of providing required parameters with accuracy and good statistics in a short time. A gamma energy is selected and the fission fragments coming in coincidence with this forward-moving gamma ray are studied. Corresponding angular distributions and most probable mass ratios are determined. It is found that the graphs of angular correlation are isotropic. There is a most probable mass ratio for each gamma ray observed, from which individual masses giving this ratio can be calculated. It is observed that there is more than one pair of fragments for each gamma ray. However, since the resolving power and the efficiency of the detector are low, some other neighboring gamma ray might be picked up. Hence, only the most probable masses of the fragments for the gamma ray chosen can be determined, and it is not possible to identify any element or its excited states. Kinetic energy data are determined. (Dissertation Abstr., 22: No. 7, 1962.)

878 PION PHOTOPRODUCTION IN HYDROGEN AND DEUTERIUM. Rafael Fessel. Thesis, Lafayette, Ind., Purdue Univ., 1961. 121p.

Bremsstrahlung excitation functions are measured for production of both positive and negative π mesons on hydrogen and deuterium. Measurements are made at ten values of bremsstrahlung energy from 186 to 277.5 Mev, with the detection system set to accept pions produced in hydrogen by 195 Mev photons at 90° in the center of mass system. The experimental apparatus includes targets of liquid hydrogen and deuterium in a thin-walled container, a 120° double focusing detection magnet, and a counter telescope array to detect the mesons. Cross sections are derived from the bremsstrahlung excitation functions. When this is done for the hydrogen data and the resultant cross section curve divided by the known photoproduction cross sections, the acceptance function for the detection system is obtained. This acceptance function disagrees with the computed acceptance function; sources of this disagree-

ment are investigated. The π^-/π^+ yield ratio on deuterium is shown to be independent of bremsstrahlung energy to within the accuracy of the data. The yield ratios are averaged and a value obtained for σ^-/σ^+ at 195 Mev, $\theta = 73°$ (laboratory). This result is $\sigma^-/\sigma^+ = 1.243 \pm 0.022$, which agrees poorly with the prediction of dispersion theory. The possible causes of this disagreement are discussed. The ratio σ_D^+/σ_H is found to depend on the bremsstrahlung energy; causes of this dependence are discussed. (Dissertation Abstr., 22: No. 7, 1962.)

879 CLASSICAL SELF-CONSISTENT NUCLEUS. Richard Gale Seyler. Thesis, University Park, Pennsylvania State Univ., 1961. 49p.

The densities of neutrons and protons are studied as a function of the distance from the center of a finite isotropic nucleus. Treating the ground state of the nucleus as a mixture of degenerate proton and neutron gases and assuming simple expressions (Yukawa function for the space and a quadratic for the momentum dependence) for the space- and momentum-dependent potential energy between two nucleons (averaged over spin) or more precisely, between two differential nuclear volume elements, a variational procedure is used that consists of minimizing the total energy of a nucleus while holding N, the number of neutrons, and Z, the number of protons, fixed, in order to deduce two coupled non-linear integral equations for the self-consistent neutron and proton spatial densities. When use is made of information concerning nuclear matter (coefficient of the volume term in the semi-empirical mass formula and the Hugenholtz-Van Hove theorem) there remain three input parameters to be selected. One of these parameters is the difference in the Fermi energies of the proton and neutron wells. This difference is assumed to be independent of A. The coupled integral equations are solved for various values of nuclear radius. The solutions are then, in turn, used to calculate the total number of nucleons, A (whose cube root can be plotted as a function of nuclear radius), the binding energy per nucleon, and the neutron-proton ratio, N/Z (both of which are plotted as functions of A and then compared with experimental data). The result of these calculations reveals that it is possible to determine "optimum" values for the three input parameters such that all resultant quantities agree with experiment. Specifically: the potential parameters are shown to be consistent with the optical potential; the total nucleon density reveals a 90% to 10% "surface thickness" independent of A and equal to 2.06 fermi; the neutron-proton ratio as a function of A fits experimental data for A greater than 10; the variation of nuclear radius, R, as a function of $A^{\frac{1}{3}}$ is expressible to a first approximation (i.e., if the range of A is not too wide) as a straight line; R actually turns out to be more accurately expressible as a linear function of $N^{\frac{1}{3}}$, with the use of which an accurate R(A) relation can be deduced; and the theoretical average binding energies reproduce the experimental values to within (at worst) 1% for all values of A between 10 and 205. The agreement of theory with experimental data is attained only at the expense of setting one of the input parameters, viz. the difference (D) between the proton and neutron Fermi levels, at a value of 2.35 Mev, which, since it is greater than the .78 Mev neutron-hydrogen mass difference, might indicate that the fit attained is only valid for nuclei unstable to electron capture. Possible resolutions to this situation are discussed. An alteration to the model is proposed whereby the value of D could be lowered by increasing the effective attraction between unlike nucleons. (Dissertation Abstr., 22: No. 7, 1962.)

880 NUCLEAR ENERGY LEVEL SCHEMES AND SYSTEMATICS IN THE HEAVY RARE-EARTH REGION. Robert Gray Wilson. Thesis, Columbus, Ohio, Ohio State Univ., 1961. 63p.

A study is made of the nuclear energy level systematics in the strongly deformed region of the heavy rare-earth elements. Twenty-nine radionuclides in this region are studied by gamma scintillation spectrometry and by gamma-gamma coincidence techniques, following their production by the irradiation of the stable enriched isotopes of erbium and ytterbium with 6-Mev protons, 17- and 24-Mev alpha particles, and thermal neutrons. Information is reported concerning the energy level structure of Er^{162}, Er^{164}, Er^{165}, Er^{166}, Er^{168}, Tm^{165}, Tm^{167}, Yb^{168}, Yb^{169}, Yb^{170}, Yb^{171}, Yb^{172}, Yb^{173}, and Yb^{174}. Energy level schemes are constructed. (Dissertation Abstr., 22: No. 7, 1962.)

881 ENERGY LEVELS OF LIGHT NUCLEI, MAY 1962. T. Lauritsen (California Inst. of Tech., Pasadena) and F. Ajzenberg-Selov (Haverford Coll., Haverford, Penna.). Contract Nonr-220(18). 341p. $4.50(NAS-NRC)

Sets 5 and 6 of 1961 constitute a unit, containing references and diagrams for helium-5 to neon-24, supplementary to the Lauritsen-Ajzenberg compilation published in Nuclear Physics, 11: 1 (1959). The reference list gives the papers published since the Nuclear Physics article, listed under the nuclei and reactions to which they are pertinent. (N.W.R.)

Particle Accelerators

Refer also to abstract 401.

882 (ANL-6602) BEAM TRANSPORT. A Selected, Annotated Bibliography. Robert R. Kepple (Argonne National Lab., Ill.). Aug. 1962. Contract W-31-109-eng-38. 289p.

References applicable to the problems of transporting charged particles in the areas external to accelerators are presented. The 891 references cover the period 1949 to 1961, with a few references both prior and subsequent to this period included. Part I is concerned with the more general aspects of electron optics. Part II contains the references that deal more directly with applications to particle accelerators. Arrangement within each part is by broad subject with cross references listed at the end of each section. An author index is included. (M.C.G.)

883 (INSJ-50) ON THE LOW MAGNETIC FIELD OF THE MAGNET FOR THE INS-1 GEV ELECTRON SYNCHROTRON. H. Sasaki and T. Yamakawa (Tokyo Univ. Inst. for Nuclear Study). July 31, 1962. 30p.

The performance of the low field in the magnet of the Institute of Nuclear Study 1-Gev Electron Synchrotron is described. The orbit displacement and the stop-band width in the stability pattern due to the field errors at the injection field are discussed and estimated. All the measurements of the magnetic field were carried out with peaking strips. The method of the field measurements and the calibration of the bias coils for the peaking strips are described. The azimuthal distribution of the field, the phase lag of the zero field between unit magnets, radial distribution of the field, magnet-end field, operation point in the stability pattern and correction of the field index, and orbit errors due to field errors at low field were determined. (M.C.G.)

884 (MSUCP-9) COMPUTATIONAL STUDY OF FACTORS DETERMINING THE OPTICAL CHARACTERISTICS OF A RESONANT EXTRACTION SYSTEM FOR A 3 SECTOR CYCLOTRON. H. G. Blosser and M. M. Gordon (Michigan State Univ., East Lansing). Jan. 1961. Contract AT(11-1)-872. 44p.

Results of studies concerned with the optical characteristics of resonant extraction in a medium energy 3 sector cyclotron are presented. It is concluded that by using adequate volts per turn, resonant extraction systems with excellent optical characteristics can be realized. The essential design requirement of such a system is a turn program which avoids regions of large flow rate gradient in the static space. (J.R.D.)

885 (MSUCP-11) EFFECTS OF FIELD IMPERFECTIONS ON RADIAL STABILITY. M. M. Gordon and W. S. Hudec (Michigan State Univ., East Lansing). Nov. 1961. Contract AT(11-1)-872. 165p.

Results of a study on these effects is presented in chapters on cyclotron three-sector fields and theory of field imperfections effects. Results of computer calculations relative to the effects of certain field bumps on specified fields are presented and compared with theoretical results. The theory of field imperfection effects is also extended to include a cyclotron field having four-sector geometry. (J.R.D.)

886 (MSUCP-12) COMPUTATION OF ELECTRIC FIELD AND POTENTIAL OF AN IDEALIZED DEE GEOMETRY. J. W. Beal (Michigan State Univ., East Lansing). Oct. 1961. Contract AT(11-1)-872. 18p.

A summary of formulas for computation of electric fields and potentials for an idealized cyclotron dee geometry is presented. A method is also given for calculation of the median plane fields and potentials. This median plane method was utilized in a computer program for various dee geometry arrangements. (J.R.D.)

887 (NIRL/R/20) ON THE POSSIBILITY OF INCREASING THE BEAM INTENSITY OF A SYNCHRO-CYCLOTRON WITH AN AUXILIARY CENTRAL DEE. F. M. Russell (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Harwell, Berks, England). June 1962. 21p.

Experimental results of tests conducted on the Harwell 110-in. synchrocyclotron with the object of increasing the beam intensity are described and examined in relation to the machine parameters. It is shown that the progressive loss of ions from the beam during acceleration can reasonably be accounted for by the variation of dee voltage amplitude. Under favorable conditions of constant dee voltage amplitude (or more exactly, constant stable area in phase-space), up to a threefold increase in beam might be achieved. (auth)

888 (ORNL-TM-362) THE ORNL ANALYTICAL CHEMISTRY DIVISION'S 150-KV COCKCROFT-WALTON GENERATOR. J. E. Strain, W. J. Hampton, G. W. Leddicotte (Oak Ridge National Lab., Tenn.). Sept. 10, 1962. Contract W-7405-eng-26. 23p.

A general description of the facilities used to house a small Cockcroft-Walton generator is presented. Preliminary information and data are given as to the operational performance of the generator, the radiation safety controls involved, and the expected use of the device. In addition, an automatic-manual device for control of tritium target usage is described. (auth)

889 (SLAC-1) TWO-MILE ACCELERATOR PROJECT. Quarterly Status Report, April 1–June 30, 1962. Final Report. (Stanford Univ., Calif. Stanford Linear Accelerator Center). July 1962. Contracts AT(04-3)-363; AT(04-3)-400. 79p.

Information concerning the initial design, engineering, and development of the Stanford two-mile accelerator is presented. Work under a contract for construction of the accelerator is also described. The construction is proceeding on the accelerator itself and its related technical environment, and on the site and buildings. Completion is scheduled in 1966. (J.R.D.)

890 A HIGH-FREQUENCY REACTION SYSTEM FOR SHORT ELECTRON LINEAR ACCELERATORS. DESIGN OF A 2-Mev MACHINE. A. Moreira. Ann. Radioelec., 16: 230-59(July 1961). (In French)

For an electron linear accelerator, a system is devised for the recovery of the residual output energy not used in the structure. The essential part of this system consists of a variable transmission directional coupler, specially designed for high-power operation. Having first defined the efficiency of the system and shown its essential properties, an approximate theory is worked out followed by an experimental investigation of this type of variable coupler. A reaction arrangement is built that consists of a traveling-wave resonant cavity in which the power is injected by the coupler. Advantage is taken of the Q of the cavity to obtain much stronger fluxes than are provided by the source. A traveling-wave linear accelerator can then be inserted in this cavity, and optimum gain adjusted (related to dissipation in the structure) by means of the variable coupler. Various phase shifters prevent the formation of spurious waves. Full-power tests (2 Mw in the ring) are carried out with a waveguide section fitted with an iris, simulating a 2-Mev accelerator. The experimental results confirm the predictions. (auth)

891 MAGNETIC CIRCUIT TECHNOLOGY OF THE BETATRON OF THE ATOMIC PHYSICS INSTITUTE OF THE RUMANIAN PEOPLE'S REPUBLIC ACADEMY. V. Bunea (Dinamo Works, Bucharest), C. Iliescu, S. Haltrich, and I. Leibovici. Electrotechnica (Bucharest), 10: No. 7, 245-9(July 1962).

Construction of a 30-Mev betatron necessitated the solution of many problems concerning assembly of cores with cylindrical geometry. In addition, accuracy of the geometry of the air gap, uniform magnetic characteristics, and realization of a good electrical isolation had to be achieved. The technical solution to these problems is described and, in particular, the use of epoxy resins for cementation and electrical isolation of the metallic foils. (OTS)

892 POLARIZED PROTON BEAM FROM CYCLOTRON. Josef Habanec (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jaderna Energie, 8: 185-8(1962). (In Czech.)

The problem of getting a polarized proton beam from a cyclotron is solved. Conclusions are based on results. The main problem now is to get an atomic beam of sufficient intensity. A method of increasing beam intensity is described. (auth)

893 THE 800-kv CASCADE GENERATOR AND PARTICLE ACCELERATOR OF THE INSTITUTE OF NUCLEAR RESEARCH. István Berecz and István Papp. Magy. Tud. Akad. At. Kut. Int. (Debrecen) Kozlemen., 4: 3-17(May 1962). (In Hungarian)

The cascade type particle accelerator of 800-kv rated voltage built at the Institute of Nuclear Research is described. For producing high voltage a selenoid rectifier was applied, whereas for the beaded supports of the accelerator "Ganz-pabit" was chosen. The inhomogenous accelerating tube of 4 steps is placed in a porcelain insulator. The ion source is of the radiofrequency type and yields about 1 ma ion current at the maximum. Some of the construction principles are also described. An account is given of the vacuum system of the accelerator and of the most important measuring and control units as well. (auth)

894 SOME PRACTICAL MODIFICATIONS ON HIGH FREQUENCY ION SOURCES. János Nagy and Péter Gombos. Magy. Tud. Akad. At. Kut. Int. (Debrecen) Kozlemen., 4: 19-31(May 1962). (In Hungarian)

A radiofrequency ion source was constructed for the 800-kv cascade type accelerator and 300-kv neutron generator built in the Institute. Besides the usual transversal magnetic field of 50 gauss, an axial magnetic field of 250 gauss intensity was also applied in the immediate neighborhood of the probe. As a result of this, the service life of the discharge tube was increased by several hundred hours but in comparison with the measurements of other authors the percentage of protons underwent no change. The quartz calyx which was built to surround the probe, contributed considerably to an increase of the service life. Measurements concerning the selection of the pre-focusing lens are summarized. With a probe of 1.3-mm canal diameter, a maximum 1.9 ma pre-focused ion current was obtained in H_2 with a gas consumption of 8 to 10 cm^3/hr. (With a probe of 1.7-mm canal diameter, at a gas consumption of 25 cm^3/hr, 2.7 ma current was obtained.) The total consumption of the ion source amounted to 800 w with prefocusing. The energy-spread of the ion beam was found to be 200 ev. Having built it into the cascade type accelerator 1 ma current was measured on the target at an accelerating voltage of 500 kv, where this amount included the secondary electrons as well. (auth)

895 PROTON SYNCHROTRON OF 7 Bev. V. V. Vladimirskii, E. G. Komar, A. L. Mints, et al. (Inst. of Theoretical and Experimental Physics). Pribory i Tekh. Eksperim., No. 4, 5-9(July-Aug. 1962). (In Russian)

The design and basic parameters of a 7-Bev proton synchrotron are discussed, and short descriptions of the construction and specifications are included. The data are presented as an introduction to more detailed articles. (tr-auth)

896 PARAMETERS OF 7 Bev PROTON SYNCHROTRON ELECTROMAGNET. N. A. Monoszon, N. S. Strel'tsov, and N. A. Ostrovskii (Scientific-Research Inst. of Electrophysical Devices, USSR). Pribory i Tekh. Eksperim., No. 4, 10-15(July-Aug. 1962). (In Russian)

Technical data and physical parameters of magnets for a 7-Bev proton synchrotron are analyzed. (tr-auth)

897 MAGNET DESIGN FOR 7 Bev PROTON SYNCHROTRON. N. S. Strel'tsov, G. M. Fedotov, B. V. Rozhdestvenskii, G. K. Gustov, V. E. Gamulina, Yu. L. Nifontov, N. N. Indyukov, E. A. Bezgachev, and V. S. Kuryshev (Scientific Research Inst. of Electrophysical Devices and Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 15-19(July-Aug. 1962). (In Russian)

Construction of electromagnet blocks and of various magnet assembly units are described. Technological problems are discussed. (tr-auth)

898 RADIOELECTRONIC SYSTEMS IN 7 Bev PROTON SYNCHROTRON. S. M. Rubchinskii, G. I. Batskikh, A. A. Vail'ev, F. A. Vodop'yanov, et al. Pribory i Tekh. Eksperim., No. 4, 20-6(July-Aug. 1962). (In Russian)

The electronic system for a 7-Bev proton synchrotron is described. The accelerating field generates 4.3 kev particle energy per cycle. Acceleration is accomplished at the seventh harmonic of the orbiting particle. Accelerating field frequencies are controlled by accelerated cluster phase and radial position. A special device was developed for measuring beam intensity, coordinates, and phase shift in relation to intensity. The constant frequency and intensity and the level of parasitic modulation are also measured. (tr-auth)

899 POWER SUPPLY FOR 7 Bev PROTON SYNCHROTRON MAGNET. N. A. Monoszon, A. M. Stolov, M. A. Gashev, F. M. Spevakova, A. Kh. Yavno, E. V. Kornakov, F. M. Kulakov, V. P. Nadgornyi, and E. G. Gorshkova (Scientific-Research Inst. of Electrophysical Instruments, USSR). Pribory i Tekh. Eksperim., No. 4, 27-33(July-Aug. 1962). (In Russian)

The operation and design of a power supply system are described, and oscillograms of the performance are given. Electromagnetic field pulsation and intensity control are discussed, and emergency devices and shielding are described. (tr-auth)

900 OPERATION OF POWER SUPPLY SYSTEM FOR 7 Bev PROTON SYNCHROTRON AT TRIGGERING START-UP MOMENT. I. F. Kleopov, S. P. Lagin, I. S. Akorokov, and N. V. Lazarev (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 33-6 (July-Aug. 1962). (In Russian)

Operational data and stability of the main ignition transformer are presented, and performance at the rectifier-inversion point is discussed. (tr-auth)

901 ELECTROSTATIC ACCELERATOR INJECTOR FOR PROTON SYNCHROTRON. I. F. Malyshev, A. V. Popovich, G. Ya. Roshal, et al. (Scientific Research Inst. of Electrophysical Instruments, USSR). Pribory i Tekh. Eksperim., No. 4, 37-45(July-Aug. 1962). (In Russian)

The design of the electrostatic injector for the 7-Bev proton synchrotron is described. The performance of the acceleration tube and gas insulator is analyzed. Descriptions are given of the ion source system, the charge current stabilization system, and the beam and magnetic field analyzer. (tr-auth)

902 VACUUM SYSTEM FOR 7 Bev PROTON SYNCHROTRON. I. F. Malyshev, A. V. Popkovich, Ya. L. Mikhelis, G. M. Martyuzov, A. D. Artemov, and N. M. Karpenko (Scientific Research Inst. of Electro-Physical Instruments, USSR). Pribory i Tekh. Eksperim., No. 4, 46-51(July-Aug. 1962). (In Russian)

The synchrotron vacuum chamber has annular regions in the magnet chamber and 112 rectilinear regions between magnet blocks. The annular areas (except for 11 with accelerating electrodes in X-aligned blocks) are corrugated, 3-mm-thick steel tubes. The chamber has an elliptic cross section with 114 × 84 mm axes. The rectilinear regions are used for pumping installations, beam observation devices, and other instruments. Fifty-six BA-05 units with semiconductor traps are used for pumping the chamber. The initial vacuum lines are connected by a ring header. Fourteen VN-1 pumping assemblies are used as collectors and rough pumps. (tr-auth)

903 VACUUM CHAMBER AND PUMPING SYSTEM IN 7-Bev PROTON SYNCHROTRON. K. K. Onosovskii (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 52-4(July-Aug. 1962). (In Russian)

The results of vacuum testing and magnet corrections in various chamber sections are described. Applications of traps with thermoelectric cooling for high-vacuum assemblies are discussed. (tr-auth)

904 PRECISION INSTALLATION OF PROTON SYNCHROTRON MAGNETS. S. V. Marfenko, A. K. Pevnev, and N. I. Porubai (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 55-65 (July-Aug. 1962). (In Russian)

Geodesic methods used in the precision installation of accelerator magnets are described. The influence of magnet distribution errors on orbit equilibrium is analyzed. (tr-auth)

905 EFFECTS OF FOUNDATION DEFORMATION ON A SYNCHROTRON PROTON ORBIT. V. V. Vladimirskii, A. S. Kobozev, S. V. Marfenko, A. K. Pevenv, N. I. Porubai, and E. K. Tarasov (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 66-9 (July-Aug. 1962). (In Russian)

A reinforced-concrete ring enclosure (CERN type) was selected for the 7-Bev proton synchrotron errected on a soft morainic soil. The ring (R = 40 m) was capable of protecting orbit operations from irregular soil settling effects. The depth of the ring foundation is about 5 m. The radial deformation of the foundation during 1959 to 1962 and vertical deformations during 1960 to 1962 are analyzed. (R.V.J.)

906 ION PASSAGE AND BEAM INJECTION SYSTEM FOR PROTON SYNCHROTRON. V. V. Vladimirskii, D. G. Koshkarev, K. K. Onosovskii, et al. (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 70-5(July-Aug. 1962). (In Russian)

An annular beam injection chamber developed with condensers distributed outside the chamber aperture reduced the condenser intensity by reducing the beam width. The system fulfills the relatively high stability requirements ($\Delta V/V \approx 10^{-3}$) demanded for precise beam placement ($\Delta r \approx 1$ to 2 mm). (R.V.J.)

907 POWER SUPPLY FOR DEFLECTING AND BLOCKING PLATES OF ION BEAM INJECTOR IN PROTON SYNCHROTRON. S. N. Boiko, L. Z. Barabash, A. B. Gerasimov, S. P. Dmitriev, V. G. Zheravov, I. M. Roife, and B. E. Stekol'nikov (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 76-80(July-Aug. 1962). (In Russian)

The high-voltage supply system for deflecting and blocking plates is described. Methods for reducing and measuring residual voltage on the plates are analyzed. (tr-auth)

908 AN ORDERED GENERATOR FOR PRECISION PROGRAMMING ACCELERATING FIELD FREQUENCY CONTROL IN PROTON SYNCHROTRON. F. A. Vidop'yanov (Inst. of Radio Technology, USSR). Pribory i Tekh. Eksperim., No. 4, 80-4(July-Aug. 1962). (In Russian)

The principle scheme, solutions, and results of experimental investigations of a wide-range generator with precision modulation, developed for 7-Bev proton synchrotron, are described. (tr-auth)

909 A MULTICHANNEL PRECISION NUMERICAL SYSTEM FOR MEASURING MAGNETIC FIELD INTENSITY AND TIME. A. A. Vasil'ev, G. I. Batsakh, Yu. A. Vasina, and N. I. Andryushchenko-Lutsenko (Inst. of Radiotechnology, USSR). Pribory i Tekh. Eksperim., No. 4, 84-9(July-Aug. 1962). (In Russian)

Descriptions are given of electronic equipment for measuring magnetic field intensity and variations. A discrete-integrator and multichannel time transducer were developed for measuring field intensity with an order of error of $\sim \pm 3 \times 10^{-4}$ and variations with an error of $\pm 2 \times 10^{-5}$. (tr-auth)

910 FREQUENCY PROGRAMMING. V. A. Uvarov (Inst. of Radiotechnology, USSR). Pribory i Tekh. Eksperim., No. 4, 89-93(July-Aug. 1962). (In Russian)

The designs of a magnetic field integrator-transducer and nonlinear transformer for programmed frequency control in the 7-Bev proton synchrotron are given. Test data confirm the high-precision of the functional transformer. (tr-auth)

911 ACCELERATION ELEMENTS AND HIGH-FREQUENCY SUPPLY SYSTEM IN PROTON SYNCHROTRONS. Yu. M. Lebedev-Krasin, B. M. Gutner, V. E. Pisarevskii, A. S. Temkin, L. Z. Barabash, V. S. Kuryshev, and A. I. Moiseev. Pribory i Tekh. Eksperim., No. 4, 94-7(July-Aug. 1962). (In Russian)

Data are given on the high-frequency control system for the 7-Bev proton synchrotron. Acceleration elements are constructed in the form of drift tubes distributed in 11 compensating magnets. Each of the 11 electrodes are supplied from separate high-frequency, seven-cascade, wide-range amplifiers. Ferrite cores are used as terminal induction. The high-frequency intensity on each electrode is 2.5 kv ± 10% at 0.65 to 8.5 Mc. The phase shift between any two channels does not exceed 30°. The total power consumption is 400 kv. The application of resonance amplifiers in terminal cascades improves the efficiency by a factor of 30 in comparison with a periodic amplifier. (tr-auth)

912 PRECISION SYSTEM FOR PROGRAMMED PROTON SYNCHROTRON ACCELERATING FIELD FREQUENCY CONTROL. F. A. Vodop'yanov, Yu. M. Zlatov, V. A. Uvarov, L. Z. Barabash, and P. I. Lebedev (Inst. of Radiotechnology, USSR). Pribory i Tekh. Eksperim., No. 4, 98-101 (July-Aug. 1962). (In Russian)

The stability and accuracy of the system for programmed accelerating-field frequency control were analyzed. Data are presented from prolonged tests and applications. (tr-auth)

913 CALCULATION OF AUTOMATIC CONTROL BY RADIAL AND PHASE PARTICLE POSITION IN PROTON SYNCHROTRON. E. L. Burshtein, Yu. S. Ivanov, and A. A. Kuzmin (Inst. of Radiotechnology, USSR). Pribory i Tekh. Eksperim., No. 4, 102-5(July-Aug. 1962). (In Russian)

The scheme of the automatic beam controlling device is analyzed. Equations were derived for the beam center motion. Frequency characteristics of reverse bond chains are evaluated. (tr-auth)

914 BEAM CONTROL BY ACCELERATING FREQUENCY IN A GIVEN BEAM. Yu. S. Ivanov and A. A. Kuzmin (Inst. of Radiotechnology, USSR). Pribory i Tekh. Eksperim., No. 4; 106-11(July-Aug. 1962). (In Russian)

The block diagram and characteristics of the beam control device are given. The triggering and operational processes are analyzed. Beam frequency corrections reduced coherent phase oscillations to ~0.05 r and stabilized the beam radial position to an order of ±1 mm. (tr-auth)

915 BEAM MODEL. A. A. Vasil'ev, A. A. Kuzmin, and Yu. S. Ivanov (Inst. of Radiotechnology, USSR). Pribory i Tekh. Eksperim., No. 4, 111-15(July-Aug. 1962). (In Russian)

The similarity between the frequency modulated generator phase synchronized by accelerating intensity and the azimuthal position of the accelerated beam was used in constructing a model for determining the characteristics of the beam controlling device. (tr-auth)

916 AUTOMATIC RADIOTECHNICAL MEASUREMENTS IN 7 Bev PROTON SYNCHROTRON. V. F. Kuz'min and S. M. Rubchinskii (Inst. of Radiotechnology, USSR). Pribory i Tekh. Eksperim., No. 4, 115-18(July-Aug. 1962). (In Russian)

Descriptions are given of an automatic measuring system for the programmed acceleration frequency control in the 7-Bev proton synchrotron. (tr-auth)

917 TWO-CHANNEL HETEROGENEITY METHOD OF MEASURING INSTANT FREQUENCIES OF PROTON SYNCHROTRON ACCELERATING INTENSITIES. A. A. Vasil'ev and V. A. Skuratov (Inst. of Radiotechnology, USSR). Pribory i Tekh. Eksperim., No. 4, 118-21(July-Aug. 1962). (In Russian)

Applications of a two-channel heterogeneous system for measuring instantaneous acceleration intensity frequencies are discussed, and descriptions are given of the design and performance of a device capable of measuring (with up to 30-c accuracy) frequencies changing at 6 Mc/sec. (tr-auth)

918 PROTON SYNCHROTRON BEAM INTENSITY MEASURING SYSTEM. A. A. Kuz'min (Inst. of Radiotechnology, USSR). Pribory i Tekh. Eksperim., No. 4, 121-6 (July-Aug. 1962). (In Russian)

The device for measuring the intensity and azimuthal distribution of beam charge was described. At 10^8 to 10^{12} particles, accuracy is ±5%. (tr-auth)

919 DEVICE FOR MEASURING PROTON BEAM POSITION. A. A. Kuz'min, S. S. Kurochkin, Yu. S. Kiselev, V. A. Mamaev, Yu. S. Pligin, and P. S. Chernov (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 126-31(July-Aug. 1962). (In Russian)

An electrode system for measuring beam position is described. Calculated electrode characteristics and experimental data are compared. The device was used for measuring beam position and oscillation frequencies during triggering. (tr-auth)

920 MEASURING THE LOOP STABILITY OF DYNAMIC COMPONENTS IN MAIN AND FOCUSING ELECTROMAGNETIC FIELDS IN 7 Bev SYNCHROTRON. V. A. Uvarov (Inst. of Radiotechnology, USSR). Pribory i Tekh. Eksperim., No. 4, 131-3(July-Aug. 1962). (In Russian)

A method is suggested for measuring the stability between the dynamic components of the main and focusing magnetic fields. It is shown that the stability between field components satisfies the necessary requirement for programming computer frequency control. (tr-auth)

921 MEASUREMENTS OF BEAM INTENSITY IN PROTON SYNCHROTRON. A. A. Kuz'min (Inst. of Radiotechnology, USSR). Pribory i Tekh. Eksperim., No. 4, 134-7(July-Aug. 1962). (In Russian)

A method is suggested for measuring betatron oscillation frequencies when a signal impressed by an oscillating beam excited resonance chains. For vertical and radial coherent betatron oscillations excited by 0.1 mm pulse intensities, the measuring accuracy is ~±0.25%. (tr-auth)

922 CALCULATIONS OF PARTICLE PHASE MOTION IN PROTON SYNCHROTRON. D. G. Koshkarev (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 138-40(July-Aug. 1962). (In Russian)

Linear approximations were found for particle phase motion parameters. The permissible noise and resonance perturbations in radio devices and in magnetic fields were determined on the basis of particle loss data. Numerical calculations were done considering adiabatic damping. (tr-auth)

923 CHARACTERISTICS OF TRANSVERSE PARTICLE OSCILLATIONS IN PROTON SYNCHROTRON. E. K. Tarasov (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 141-52(July-Aug. 1962). (In Russian)

Equations were derived for steady particle motion in an accelerator and for calculating magnetic system parameters. Floquet functions for periodic orbits and functions and variables for magnetic system parameters are tabulated. (tr-auth)

924 CALCULATIONS AND DESIGN OF COMPENSATING POLE-FACE WINDINGS IN PROTON SYNCHROTRON. V. V. Vladimirskii, V. S. Borisov, T. G. Smolyankina, V. K. Gorbik, Z. A. Kurdyukova, V. A. Moskovets, and V. S. Smirnov (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 153-8 (July-Aug. 1962). (In Russian)

Distributions of pole-face winding for compensating the gap in C-shaped magnets limited by hyperbolic poles and straight neutral pole are calculated. The windings are of rigid construction with expoxy resin as insulation. (tr-auth)

925 CORRECTION SYSTEMS FOR PROTON SYNCHROTRON MAGNETIC FIELD. F. M. Kulakov, A. A. Kardash, P. S. Bobikov, et al. (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 158-67(July-Aug. 1962). (In Russian)

Magnetic field configuration compensation in the 7-Bev strong-focusing accelerator was achieved by means of a series of correcting devices that control the betatron oscillation frequency and eliminate orbit resonance perturbations. The power supply and switching system of the compensation winding and the corrective effects are analyzed. (tr-auth)

926 EFFECTS OF PROTON SYNCHROTRON ELECTROMAGNET PARASITIC PARAMETERS ON THE MAGNETIC FIELD ASYMMETRY. N. A. Monoszon, A. M. Stolov, and F. M. Spevakova (scientific-Research Inst. of Electrophysical Instruments, USSR). Pribory i Tekh. Eksperim., No. 4, 168-71(July-Aug. 1962). (In Russian)

Effects of the volume and ohmic resistance of electromagnet insulation on the azimuthal magnetic field asymmetry and the compensation of the asymmetry are analyzed. (tr-auth)

927 MEASUREMENTS AND CALIBRATION OF PROTON SYNCHROTRON ELECTROMAGNETS UNDER OPERATIONAL CONDITIONS. A. G. Alekseev, M. D. Veselov, I. A. Mozalevskii, B. V. Rozhdestvenskii, and G. V. Trokhachev (Scientific-Research Inst. of Electrophysical Instrumentations, USSR). Pribory i Tekh. Eksperim., No. 4, 172-8(July-Aug. 1962). (In Russian)

Characteristics of proton synchrotron electromagnets were measured by integrating induction coil signals with a ferrite circuit acting as a magnetic field transducer for cutting off the signal. The design and operation of the assembly is described. The results of dynamic calibrations and typical magnet characteristics are quoted. (tr-auth)

928 APPLICATIONS OF PERMALLOY TRANSDUCERS FOR MASS MAGNETIC MEASUREMENTS IN PROTON SYNCHROTRONS. A. G. Alekseev, A. S. Gorelkin, I. A. Mozalevskii, I. V. Mozin, B. I. Tarasov, and G. V. Trokhachev (Scientific-Research Inst. of Electrophysics Instrumentations, USSR). Pribory i Tekh. Eksperim., No. 4, 179-84(July-Aug. 1962). (In Russian)

An accurate measuring assembly using permalloy transducers for an electromagnet injection field H = 90 gauss and excitation from the main power supply is described. The maximum error is 0.1%. (R.V.J.)

929 INVESTIGATIONS AND COMPENSATIONS OF MAGNET C-BLOCK CHARACTERISTICS IN PROTON SYNCHROTRON WEAK FIELDS. A. N. Talyzin, L. L. Gol'din, G. V. Trokhachev, et al. (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 184-92(July-Aug. 1962). (In Russian)

Measurements on C-blocks were carried out in residual injection fields. The mean square magnetic induction deflection in residual field was 4.25% and in injection field, 1.4% (beyond permissible limits). Compensation by means of resistances and shim windings (and by magnet shifting) reduced the straggling characteristics and equalized the C-block fields. (R.V.J.)

930 AUTOMATIC MEASURING AND RECORDING DEVICE FOR ALTERNATING MAGNETIC FIELDS. V. N. Luzin, I. A. Radkevich, and V. V. Sokolovskii (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 192-6(July-Aug. 1962). (In Russian)

A recording magnetometer with a permalloy transducer and using a potentiometer for measuring and recording currents in the compensation coil is described. The field measuring accuracy is ±0.03 gauss; the device is capable of measuring field shift at a rate <4.5 gauss/sec. (R.V.J.)

931 MAGNETIC FIELD IN PROTON SYNCHROTRON C-MAGNET GAP FOLLOWING COMPLETED CYCLE. V. N. Luzin, I. A. Radkevich, and V. V. Sokolovskii (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 196-9(July-Aug. 1962). (In Russian)

Variations in magnetic field in the C-magnet gap during the pause between the completion and starting of cycles were recorded with a magnetometer. The variations were recorded at various equilibrium orbit azimuthals and cycle frequencies and at maximum cycle induction. (tr-auth)

932 DISTRIBUTION OF MAGNETIC BLOCKS ALONG ACCELERATOR RING. L. L. Gol'din and A. G. Stadnikov (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 199-202(July-Aug. 1962). (In Russian)

Orbit equilibrium distortions caused by magnet stagger were compensated by redistributing the magnets. (R.V.J.)

933 POWER SUPPLY SYSTEM FOR MAGNETIC MEASUREMENTS. I. F. Kleopov and N. V. Lazarev (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 203-6(July-Aug. 1962). (In Russian)

A power supply system capable of producing every 30 sec a succession of current cycles in five series-connected magnet blocks (L_{Σ} = 0.15 h and R_{Σ} = 0.11 ohm) and simulating the synchrotron main power supply is described. A system for current rate, rise, drop, and amplitude (from 1500 to 3000 amp) control is also described. (tr-auth)

934 MEASURING OF MAIN MAGNET CHARACTERISTICS IN PROTON SYNCHROTRON C BLOCKS. V. S. Borisov, L. L. Gol'din, Yu. M. Goryachev, N. N. Grekov, A. P. Ryabkov, S. V. Skachkov, and A. N. Talyzin (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 206-12(July-Aug. 1962). (In Russian)

Magnetic induction and gradient distribution along and between the blocks determined the radial distance between the focusing and defocusing block groups and helped determine the magnetic field compensation parameters. (tr-auth)

935 MAGNETIC FIELD CONFIGURATIONS IN PROTON SYNCHROTRON X BLOCKS. M. A. Veselev, L. L. Gol'din, I. V. Kirpichnikov, G. S. Lomkatsi, Z. S. Sidorenko, and E. A. Sysoev (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 212-17 (July-Aug. 1962). (In Russian)

Magnetic field configurations in 14 compensating x-blocks were measured at various induction levels between 80 and 8000 gauss. Accuracy was better than 0.1%. Permalloy transducers were used for measuring low fields and induction coils were used for medium and high fields. (R.V.J.)

936 VACUUM CHAMBER EFFECTS ON MAGNETIC FIELDS IN PROTON SYNCHROTRON. Yu. M. Goryachev, N. N. Grekov, and S. V. Skachkov (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 217-23(July-Aug. 1962). (In Russian)

Measurements of vacuum chamber influence on magnetic fields showed a considerable ferromagnetic effect in one section of the chamber that demanded correction or replacement. Control methods and corrections by heating are described. (tr-auth)

937 CORRECTIONS FOR HORIZONTAL COMPONENT OF LOW INDUCTION MAGNETIC FIELD IN PROTON SYNCHROTRON. V. V. Barmin, G. K. Bysheva, G. K. Tumanov, et al. (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 223-9(July-Aug. 1962). (In Russian)

Permalloy transducer measurements of residual fields of C-magnets showed that neutral plane distortions are determined by a neutral pole. It was also shown that distortions diminish in increasing fields. Methods for neutral plane correction are described. (tr-auth)

938 ASSEMBLY FOR MEASURING MAGNETIC FIELD BY MEANS OF PERMALLOY TRANSDUCERS. I. A. Radkevich, V. V. Sokolovskii, A. N. Talyzin, L. L. Gol'din, G. K. Bysheva, and Yu. M. Goryachev (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 229-36(July-Aug. 1962). (In Russian)

Magnetic induction and gradients in low fields of C-blocks were measured using magnetometers with permalloy transducers with an order of error of 0.1% for the field and 0.2% for the gradient. The assembly for measuring field configurations is described. (tr-auth)

939 ASSEMBLY FOR MEASURING THE VELOCITY OF MAGNETIC FIELD CHANGES IN PROTON SYNCHROTRON. A. G. Alekseev, M. P. Vasil'ev, and I. V. Mozin (Inst. of Scientific Research in Electrophysics Instrumentation, USSR). Pribory i Tekh. Eksperim., No. 4, 236-9(July-Aug. 1962). (In Russian)

Descriptions are given of an assembly for measuring the velocity of magnetic field changes in the 7-Bev proton synchrotron. The device is capable of measuring rate of change and absolute magnitude with an accuracy of 0.1%. (tr-auth)

940 EFFECTS OF POWER SUPPLY VARIATIONS ON MAGNET CHARACTERISTICS IN PROTON SYNCHROTRONS. V. V. Sokolovskii, I. A. Radkevich, and L. L. Gol'din, et al. Pribory i Tekh. Eksperim., No. 4, 240-4 (July-Aug. 1962). (In Russian)

Effects of power supply instability on magnet characteristics at a start-up field of ~90 gauss were investigated. Errors arising in low-field measurements due to changing current are analyzed. (tr-auth)

941 FREQUENCY MEASUREMENTS ON TRANSVERSE BEAM OSCILLATIONS IN 7-Bev PROTON SYNCHROTRON. V. V. Vladimirskii, L. Z. Barablash, Yu. S. Pligin, M. A. Veselov, A. N. Talyzin, E. K. Tarasov, and A. A. Kuz'min (Inst. of Theoretical and Experimental Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 245-7(July-Aug. 1962). (In Russian)

Measurements of betatron oscillations, based on beam position oscillograms, are described. (tr-auth)

942 ACCELERATION OPERATIONS IN 7 Bev PROTON SYNCHROTRON. V. V. Vladimirskii, L. L. Gol'din, Yu. S. Pligin, et al. (Inst. of Theoretical and Experimental

Physics, USSR). Pribory i Tekh. Eksperim., No. 4, 248-55 (July-Aug. 1962). (In Russian)

Beam characteristics during the first cycle, during free-beam acceleration, and at acceleration moments were measured, and compensation methods for magnetic fields and radiofrequency assemblies are suggested. (tr-auth)

943 INVESTIGATION OF PARTICLE MOTION IN A RING PHASATRON. A. A. Zhuravlev, I. N. Ivanov, M. Karmasin, V. I. Kotov, E. A. Myae, V. A. Oboznyi, Yu. L. Obukhov, and V. A. Petukhov. Zh. Tekhn, Fiz., 32: 905-13(Aug. 1962). (In Russian)

Particle orbit deformation induced by perturbations in electromagnet sections was measured. The results are correlated with theoretical calculations. The resonance method of determining free oscillation frequencies and data on electron beam behavior at various stages of operation are discussed. (tr-auth)

944 PARTICLE LOSS CAUSED BY THE MULTIPLE COULOMB SCATTERING IN A CYCLE ACCELERATOR. Yu. F. Orlov and S. A. Kheifets. Zh. Tekhn, Fiz., 32: 919-23(Aug. 1962). (In Russian)

Universal curves were constructed for particle losses due to Coulomb multiple scattering during cyclic acceleration at arbitrary injection energies. The attenuation of transverse particle oscillations was evaluated, and it is shown that $(A^2 \text{ max})/(A^2 \text{ permis})$, A^2 = mean square oscillation amplitude, is the universal parameter. (R.V.J.)

945 ON THE THEORY OF NON-LINEAR BETATRON OSCILLATIONS IN STRONG FOCUSING ACCELERATORS. V. K. Grishin. Zh. Tekhn. Fiz., 32: 924-30(Aug. 1962). (In Russian)

An approximation analysis was made of nonlinear equations for betatron particle oscillations. An attempt was made to find nonlinear oscillation amplitude limitations. Maximum betatron oscillation amplitudes with particles unavoidably captured by resonance were found. (tr-auth)

946 KRAMER'S AND HYPERGEOMETRICAL SERIES METHOD FOR THE CALCULATION OF PARTICLE LOSS IN CYCLE ACCELERATORS. A. N. Didenko and V. A. Serdyutskii (Scientific-Research Inst. of Nuclear Physics, Electronics, and Automation at Tomsk Inst. of Tech., USSR). Zh. Tekhn. Fiz., 32: 931-3(Aug. 1962). (In Russian)

Particle losses due to quantum fluctuations are accurately determined by the majoring solution and hypergeometric series, however, the determination is quite complicated. An attempt is made to prove analytically that the hypergeometric series and Kramer's method, used by K. W. Robinson (CERN, Symposium, Geneva, 293, 1959), are equivalent within a certain range of parameters. (R.V.J.)

947 ELECTRON COMPUTER CALCULATIONS FOR PARTICLE CAPTURE IN A BETATRON. S. P. Lomnev. Zh. Vychislitel. Mat. i Mat. Fiz., 2: 491-4(1962). (In Russian)

A particle capture problem is resolved in cylindrical coordinates. Neglecting z and φ oscillations the one-dimensional case of r is analyzed by integration along z and φ and by writing in the equation of motion for geometric variations with coordinates r_j, $z_{min} < z \leq z_{max}$ and $0 \leq \varphi \leq 2\pi$. The evaluation of the maximum charge accelerated on the safe orbits N_{max} is achieved by resolving the initial equation for arbitrary beam distribution and variable particle flux from the moment of final capture and by statistical treatment of the results. (R.V.J.)

Plasma Physics and Thermonuclear Processes

948 (62-RL-2936E) NEUTRON YIELDS FROM HIGH-POWER θ-PINCH DEVICE. H. C. Pollock, L. M. Goldman, and W. F. Westendorp (General Electric Co. Research Lab., Schenectady, N. Y.). Feb. 1962. 13p.

A fast compression system which utilizes a maximum of 384,000 joules of energy is discharged in a single-turn, shaped coil around either a 4-in.- or a 6-in.-dia discharge tube. A magnetic bias field is initially produced in the coil antiparallel to the field on the first half cycle of the main discharge. Neutron production in deuterium plasmas was measured as a function of bank voltage, bias field, and deuterium pressure. The appearance of the compressed plasma was photographed in the axial direction of the coil using a fast image converter camera which takes either streak or three frame pictures. (auth)

949 (AD-273067) INVESTIGATIONS ON THE DIRECT CONVERSION OF NUCLEAR FISSION TO ELECTRICAL ENERGY IN A PLASMA DIODE. Annual Report, January 1, 1961 to January 31, 1962. Frank E. Jamerson, ed. (General Motors Corp. Research Labs., Warren, Mich.). Jan. 31, 1962. Contract Nonr-3109(00). 83p.

Results of experimental and theoretical investigations are presented on the use of a nuclear generated plasma in a noble-gas plasma-diode thermionic converter. Related programs of emitter materials development and plasma measurements are described. These are presented in individual reports on noble gas plasma diode inpile experiment IV, noble gas plasma diode inpile experiment V, plasma sheath theory with voltage-independent ion sources, development of emitter materials for use in noble gas plasma-diodes, thermionic emission of UC–Nb and UC–Re, and spectroscopic measurements of plasma temperatures and densities in high pressure Cs-Diodes. (auth)

950 (AD-273247) THE NON-ISENTROPIC PERTURBATION OF A CENTERED MAGNETOHYDRODYNAMIC SIMPLE WAVE. Roy M. Gundersen (Wisconsin. Univ., Madison. Mathematics Research Center). Nov. 1961. Contract DA-11-022-ORD-2059. 11p. (MRC-TSR-280).

Since the equations governing the motion of a perfectly conducting compressible fluid belong to the class of reducible hyperbolic equations, it is possible to build up a theory of simple waves rather parallel to that of ordinary gas dynamics. For a monatomic gas, analogs of the Riemann invariants can be determined explicitly. Because of the existence of a relation between the induction and the local speed of sound, valid for uniform of simple wave flows, it is possible to reduce the number of governing equations so that previous results may be extended to determine the non-isentropic perturbation of a centered magnetohydrodynamic simple wave. (auth)

951 (AD-273267) AMPLIFICATION OF SIGNALS IN AN ELECTRON BEAM THROUGH A PLASMA. Technical Note No. 36. Philip Panzen and G. Nomicos (Republic Aviation Corp., Farmingdale, N. Y.). Feb. 15, 1962. Contract AF33(657)-7988. 18p.

The amplification factor of the modulation of an electron beam of finite radius passing through an infinite plasma is computed. Two cases are considered; an electron beam confined to move longitudinally by an infinite longitudinal field, and an electron beam free to move transversely under the action of time varying fields. In the first case the amplification is due to bunching in the interior of the

electron beam while in the second case the amplification is due to the scalloping boundary of the electron beam. In both cases the magnitude of the amplification is about the same as that occurring in a infinite electron beam passing through an infinite plasma. (auth)

952 (AFCRL-1103) COULOMB COLLISIONS IN STRONG RF ELECTRIC FIELDS. Scientific Report No. 15; Series No. 60, Issue No. 397. G. August (California. Univ., Berkeley. Electronics Research Lab.). Aug. 24, 1961. Contract AF 19(604)-2270. 55p. (AD-271764)

An expression was derived for the electron-ion collision frequency in r-f electric fields. The r-f collision frequency is nearly given by Spitzer's usual collision frequency formula, when the temperature is modified to include the rms electron energy. The expression depends on the electron-ion scattering interaction time being small compared to one r-f period. It normally applies only to strong r-f electric fields, but under some circumstances it also applies to weak r-f electric fields. The derivation is non-relativistic and so applies only to a range of r-f electric field strengths. R-f power losses were calculated assuming that multiple Coulomb collisions are the dominant loss mechanism. When heating is neglected, the r-f power loss for the strong r-f electric field case becomes substantially independent of r-f power level. For plane waves propagating through plasmas, the r-f losses actually decrease as the r-f power level increases. For devices employing reflection of plane waves from plasmas, the r-f power loss is approximately given by using an electric field-strength corresponding to the electron's r-f velocity being twice its thermal velocity, and using the thermal collision frequency. (auth)

953 (ASD-TDR-62-412) DISCHARGE EFFECTS IN A CESIUM DIODE. James Lawson Coggins (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). Aug. 15, 1962. Contract AF33(616)-7624. 36p.

An investigation to determine the feasibility of neutralizing the electron space charge in Cs thermionic converters with ions formed by the collisions of electrons with neutral atoms is described. Equations were set up for the ion density and subsequent potential function for a low-pressure plasma in which the ions are formed by collisions of atoms with electrons emitted from the cathode with a Maxwellian velocity distribution. The special case of zero field at the emitter was taken to simplify the mathematics. Voltage versus current characteristics were determined experimentally for a Cs diode with a low work-function impregnated W emitter operating at 1410°K and an electrode spacing of 0.254 cm. Cs vapor pressures corresponding to condensation temperatures of 30, 100, and 155°C were used. The results indicate that higher Cs pressures, leading to more dense plasmas and successive collisions between electrons and excited atoms, are needed for complete space-charge neutralization. (auth)

954 (LA-2715) THE SCATTERING OF ELECTROMAGNETIC WAVES BY NONEQUILIBRIUM PLASMAS. George L. Lamb, Jr. (Los Alamos Scientific Lab., N. Mex.). Mar. 1, 1962. Contract W-7405-eng-36. 64p.

The frequency spectrum of the cross section for the scattering of electromagnetic waves by a plasma is known to be proportional to the Fourier transform of the two-point time-dependent correlation function for the electron density fluctuations of the plasma. This spectrum was previously obtained for two-component plasmas in complete thermal equilibrium. In the present calculation, methods developed by Rosenbluth and Rostoker are employed to obtain the spectrum for plasmas which are out of thermal equilibrium but sufficiently stationary in time for fluctuations about their state of quasi-equilibrium to take place. It is found that the spectrum has the same functional dependence upon the nonequilibrium distribution function as was found for plasmas in complete thermal equilibrium. The specific nonequilibrium plasmas considered are ions and electrons at different temperatures, and counter streaming ions and electrons with various temperature ratios. Amplification of the spectrum in the ion wave region as the relative drift velocity of ions and electrons approaches the critical drift velocity for the onset of electrostatic instability is obtained, as well as the enhancement of this amplification with the lowering of the ion temperature. (auth)

955 (MATT-145) FOUR LECTURES ON FUSION POWER. Robert G. Mills (Princeton Univ., N. J. Plasma Physics Lab.). Sept. 21, 1962. Contract AT(30-1)-1962. 60p.

Lectures are presented on the interest in thermonuclear power production, various considerations concerning fusion reactors, and power production estimates. (J.R.D.)

956 (NP-12150) PLASMA BOUNDARY LAYERS. James A. Fay (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Dec. 1961. Contract AF49(638)-659. 34p. (AMP-83)

A review is given of recent work on boundary layers in electrically-conducting fluids. This includes a discussion of the difference between ordinary boundary layers and plasma boundary layers with special reference to the new dimensionless parameters for the magnetic case, including those which arise from the microscopic structure of the fluid. The convection of current and vorticity along magnetic field lines by the Alfven wave mechanism is shown to be the principal new propagation mechanism in magneto-hydrodynamic boundary layers. Recent work in inertial boundary layers, channel flows, wakes, and electrode boundary layers is summarized. (auth)

957 (NP-12153) PLASMA ACCELERATION BY A 2.4 KMC GRADIENT ELECTRIC FIELD. H. W. Hendel, T. Faith, T. T. Reboul (Radio Corp. of America. Astro-Electronics Div., Princeton, N. J.) and D. D'Agostini (Radio Corp. of America. RCA Labs., Princeton, N. J.). Sept. 12, 1962. Contract AF49(638)-658. 30p. (AED-1609)

The acceleration of plasma by r-f gradient fields was previously demonstrated. Plasma velocities up to 2×10^6 cm/sec for Hg ions were measured for applied r-f fields less than 200 v/cm at 140 and 330 Mc and found to be in agreement with a theory developed on the basis of energy considerations. The applied frequency was raised to 2.4 kMc. Greater resolution of the velocity measurement was achieved by pulsing the accelerating r-f field. The r-f pulse time delay can be adjusted relative to the initiation of the plasma pulse to select a plasma volume element of critical density and thus accelerate to optimum velocity. The ion velocity was found to depend approximately linearly on the field strength. The plasma density in the 2.4 kMc experiments was higher than that of the previous experiments by a factor of about 100. The highest bulk ion velocity measured at 700 v/cm was 8×10^6 cm/sec. The data, obtained at applied frequencies one order of magnitude higher than those previously employed and taken over a wider field strength range, were in good agreement with the theory when the functional dependence of the collision frequency upon plasma density and r-f field strength was considered. In the range of the experiments, the increase in collision frequency with increasing applied frequency reduced the gain in thrust expected from the use of a more dense plasma at a higher applied frequency. (auth)

958 (NP-12154) ELECTROSTATIC ACCELERATION OF NEUTRAL PLASMAS—MOMENTUM TRANSFER THROUGH MAGNETIC FIELDS. G. S. Janes, J. Dotson, and T. Wilson (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Sept. 1962. Contract AF49(638)-659. 26p. (AMP-88)

Electrostatic plasma accelerators which avoid the space charge limitations of conventional ion rockets are described. Additional advantages for these devices include moderate requirements on magnetic field strength, and on power level. In cylindrical and annular geometries, neutral plasmas can exhibit axial acceleration under the influence of externally applied axial electrostatic fields in the presence of radial magnetic fields. Ions will accelerate freely in the presence of such an axial electric field if both the ion gyro radius and the ion mean free path are large relative to the apparatus size. The axial drift of electrons, however, will be strongly inhibited by the radial magnetic field if the electron gyro radius is small relative to both the apparatus size and to the electron mean free path. The resulting circumferential drift of electrons constitutes an electric current which in turn produces a magnetic reaction force on the external field coils. The electric field is impressed upon the plasma by means of an upstream anode and a downstream cathode. This cathode serves as a source of electrons for space charge neutralization of the exit plasma beam. A critical engineering question concerns the effectiveness of the radial magnetic field in inhibiting the upstream diffusion of electrons. This diffusion is an energy loss mechanism. Both classical and anomalous (Bohm type) electron diffusion models are considered. Experiments are described which substantiate the existence of the mechanism for momentum transfer to neutral plasmas. The experiments are in approximate agreement with the anomalous (Bohm type) diffusion model and are in disagreement with the classical diffusion model. The engineering significance of this result and possible approaches for dealing with it are considered. (auth)

959 (NP-12160) PLASMA FLOW IN A MAGNETIC ANNULAR ARC NOZZLE. R. M. Patrick and W. E. Powers (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Sept. 1962. Contract AF49(638)-659. 28p. (AMP-86)

The performance characteristics of a magnetic annular arc were experimentally investigated. This configuration consists of two coaxial electrodes separated by an annular passage through which the plasma flows with a steady solenoidal magnetic field throughout the flow region. Initial tests at small magnetic Reynolds number in a constant area configuration demonstrated that the impedance of the magnetic annular arc can be increased by a factor of 25 with the application of an axial magnetic field between the coaxial electrodes. This increased impedance was shown to be due to Hall currents that flow around the annulus between the electrodes. In addition to plasma heating, the interaction between the plasma currents and the magnetic field produced directed energy comparable to the thermal energy. To exhibit thrust, a 10° half angle nozzle was added and surveys of the plasma properties taken at the nozzle exit are presented. A 50° half angle nozzle configuration was also studied in which most of the plasma currents flow in the expanding flow region. An effort was made to produce directed axial energy through the interaction of the circulating Hall currents and the radial component of the magnetic field. Argon plasma properties were obtained by survey measurements of stagnation pressure, the electric field variation throughout the plasma flow, the flow direction, and the axial velocity profile of the flow. The stagnation pressure in the steady plasma flow was measured with an impact probe, the flow angles with special yaw probes, and the local electric potential in the plasma was measured with a high impedance probe. The velocity was obtained by utilizing a mass flow probe. The results from the plasma flow measurements indicated that the flow in the wide angle nozzle is dominated by Hall currents. (auth)

960 (NP-12171) SUMMARY OF SHERWOOD ACTIVITIES. (Defense Atomic Support Agency. Field Command, Albuquerque, N. Mex.). Aug. 15, 1962. 15p.

Activities in programs on controlled thermonuclear reactions are summarized. Descriptions on the research status of devices at LASL, LRL, ORNL, and Princeton are given along with discussion of other U. S. research. Development of experimental devices, and research conducted by foreign nations are also summarized. (J.R.D.)

961 (PPL-TR-61-17(398)) A SUPERSONIC PLASMA BEAM. Herbert Malamud and Benjamin Bederson (Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.). June 1961. Contract AF49(638)-552. 34p. (AFOSR-1429)

The theory and design of a cold plasma beam facility are described. A supersonic beam of alkali metal vapor is produced by conventional wind tunnel techniques. The vapor is ionized to a high degree by the process of surface ionization on the heated (W) walls of the acceleration nozzle, which also acts as an electron emitter to provide charge neutralization in the beam. The limitation on the plasma flux is the effect of particle recombination in the non-equilibrium situation existing in the nozzle. Estimates based on the presently available data on recombination rates give a maximum beam flux of 10^{17} ions/cm^2-sec. (auth)

962 (TID-16535) THE TWO-STREAM INSTABILITY IN A FINITE PLASMA (thesis). Gordon K. Soper (Tennessee. Univ., Knoxville). Aug. 1962. 79p.

The dispersion relation for small-amplitude waves in a fully ionized two-stream plasma was derived. Two different geometries were employed: the infinite slab of width 2a and the hollow cylinder of infinite length and radius a. Equations are presented along with the assumptions concerning the type of geometry employed. The boundary effects were calculated using the physical model of particles migrating to the interface after perturbation of the plasma. For both geometries, three distinct oscillatory modes were found to exist: two surface modes and one body mode. Analysis of the surface modes showed that the dispersion relations were relatively insensitive to the boundary effects except in limit of very small ka (slab geometry), i.e. for long-wavelength oscillations; or in the cylindrical geometry for $l = 0$, where l is the azimuthal wave vector. For the different cases of geometry, where instability criterions were not able to be rigorously derived, the unstable regions were indicated from a graphical analysis of the dispersion relations. (M.C.G.)

963 (TID-16997) THE USE OF ATOMIC BEAMS AS A PROBE FOR STUDYING LOW DENSITY PLASMAS. Quarterly Report for July 1, 1962–October 1, 1962. (New York Univ., New York). Contract AT(30-1)-2397. 6p.

A charge transfer cell was designed with the intention of minimizing space charge effects, since space charge represents a particularly serious handicap in the low energy (1 to 100 ev) region. Some cesium triode characteristics of the cell are presented in the form of curves of plate current versus plate voltage for several different

voltages of grid (G1) to cathode. The potassium beam-noble gas attenuation studies were continued. The characteristics of a plasma source are described. The source consists of two water cooled copper spindles around which very thin tantalum, tungsten, or rhenium sheet may be wound. The cesium will enter the source through a hole drilled in the face of one of the spindles. (N.W.R.)

964 LOW-PRESSURE SPARK GAP. E. Oger and B. Bonvalot (Compagnie Generale de Telegraphie Sans Fil, France). Ann. Radioelec., 16: 309-17(Oct. 1961). (In French)

A multiple-electrode, low-pressure spark gap is developed with a view to using it as a plasma "crow-bar." A description is given of the principle of operation of this spark-gap, which can be fired while the voltage at its terminals is low. Problems arising in the development of the spark gap are described. The device is constructed and used to produce 1000 discharges at 80 ka and 50 kv, the electrodes behaving very well. (auth)

965 THE DEVELOPMENT OF AN ELECTROSTATIC PLASMA INSTABILITY IN A STRONG MAGNETIC FIELD. A. A. Vedenov and E. P. Velikhov. Dokl. Akad. Nauk SSSR, 146: 65-8(Sept. 1, 1962). (In Russian)

The development of perturbations in an unstable plasma, and the properties of a mildly turbulent plasma can be investigated by using a quasilinear theory of the plasma. Solution of the quasilinear equations is simplified, if the spectrum of non-equilibrium noise in the turbulent plasma is homogeneous. The spectrum of plasma oscillations is almost homogeneous in a strong magnetic field. It is assumed that the constant magnetic field is so large that the ratio of the gas pressure nT to the magnetic pressure $H^2/8\pi$, and the ratio of the frequency of the oscillation ω to the hydrofrequency are small. The electric field of the oscillation is a potential field, and there is no perturbation of the magnetic field. A set of equations for the quasilinear kinetics was written, and it is shown that the diffusion of particles is homogeneous, if the initial noise is small. Expressions were derived for the noise intensity, the particle diffusion, and the width for the energy distribution of the oscillations. (TTT)

966 ALTERNATING-CURRENT GENERATION WITH MOVING CONDUCTING FLUIDS. H. A. Haus (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 33: 2161-72(July 1962).

A one-dimensional small-amplitude analysis is presented of alternating-current generation by a stationary electromagnetic circuit coupling to waves in a moving, perfectly conducting fluid. In a uniform applied d-c magnetic field the waves in the fluid are either compressional waves if the time-average velocity v_0 is transverse to the d-c magnetic field, or Alfvén waves if $\bar{v}_0$ is along the d-c magnetic field. It is shown that, for velocities v_0 greater than the velocity of propagation c of the compressional or Alfvén waves, self-excited oscillations may be produced in a resistively loaded coil coupling to the fluid. In a traveling-wave circuit and in a resistively loaded distributed circuit coupling to the fluid, growing waves are found that result from a transformation of the fluid energy into electromagnetic energy. There is an analogy between these power-generation mechanisms and those employed in microwave electron-beam tubes. The results of two- and three-dimensional analyses are summarized in order to show that the phenomena predicted by the one-dimensional analysis occur in less idealized geometries. Possible applications are discussed, with reference to a-c power generation by using combustion gases or a flow of a high-temperature plasma. (auth)

967 AXIAL QUASI-BRILLOUIN STREAMS. M. H. Miller (Univ. of Michigan, Ann Arbor). J. Appl. Phys., 33: 2247-8(July 1962).

A nonlaminar model for axially uniform electron streams is postulated, and conditions for which the model is consistent with physical requirements are derived. The character of the current density profiles permitted by the model is discussed. (auth)

968 DETERMINATION OF PLASMA PROPERTIES BY FREE-SPACE MICROWAVE TECHNIQUES. R. Buser and W. Buser (U. S. Army Signal Research and Development Lab., Fort Monmouth, N. J.). J. Appl. Phys., 33: 2275-82(July 1962).

Time-resolved free-space microwave measurements are used to study the loss mechanisms in the afterglow of an intense He discharge between 100 and 1000 μ. The method of evaluation is developed, and the results of the measurements and their accuracy are given. Some of the problems and limitations of the microwave method are discussed; in particular, plots of the field pattern between the horns are presented, indicating that a reasonable interpretation in terms of an integrated path length is possible. (auth)

969 CONTINUUM RADIATION FROM IONIZED RARE GASES IN REFLECTED SHOCK WAVES. Frederick H. Mies (Brown Univ., Providence). J. Chem. Phys., 37: 1101-11(Sept. 1, 1962).

Observations were made of the temperature, pressure, and frequency dependences of the visible and ultraviolet continuum radiation emitted by the thermally ionized rare gases Ar, Kr, and Xe. The plasmas, whose continua generally are attributed to the radiative recombination of free electrons and ions, were formed in reflected shock waves in which the equilibrium temperatures range from 7500 to 12000°K and the electron densities range from 10^{15} to 10^{18} cm^{-3}. Some distance behind the reflected shock wave, a region is found which possesses the predicted shock properties and in which the intensity of the continuum radiation attains a steady-state value. This steady-state intensity was examined at seven wavelengths from 2451 to 4800 Å; in addition, the ratio of the Kr continuum to the 4319.6 Å Kr line intensity was observed. The continuum intensity is shown to be proportional to the electron density squared and essentially, independent of the ion involved. The observed $e^{-h\nu/kT}$ decay of the intensity in the ultraviolet, together with the total temperature dependence and the measured absolute intensity of the continuum, demonstrates that the continuum originates from radiative recombination. The expected temperature and pressure behavior also is found for the Kr line emission. (auth)

970 A UNIFIED THEORY OF THE NONLINEAR OSCILLATIONS OF A COLD PLASMA. C. L. Dolph (Univ. of Michigan, Ann Arbor). J. Math. Anal. and Appls., 5: 94-118(Aug. 1962).

Nonlinear oscillations of a cold plasma are formulated in terms of systems of first-order partial differential equations having equal principal parts. The treatment is carried out for cases in which the magnetic field is zero or a constant, and in which there is only one independent spatial variable. Traveling-wave solutions are discussed. Generalized orthogonal coordinate systems are used. An approach to the case of three independent spatial variables is suggested. It is assumed that only single streaming occurs, so that all quantities are single-valued functions of Lagrangian coordinates. (T.F.H.)

971 GREEN'S FUNCTION FOR THE LINEARIZED VLASOV EQUATION. Harold Weitzner (New York Univ., New York). Phys. Fluids, 5: 933-46(Aug. 1962).

The Vlasov equation is considered without magnetic fields, linearized about a state with no electric fields or space or time variation. Integral representations for the Green's functions are presented for systems of one, two, and three dimensions. For the one-dimensional stable case, two asymptotic expansions of the electric field for large time are presented. Similar expansions are given for a specific example of a one-dimensional unstable plasma. In two and three dimensions, asymptotic expansions are exhibited for arbitrary plasmas having cylindrical or spherical symmetry. (auth)

972 LONG-WAVELENGTH PHENOMENA IN A PLASMA. Richard L. Liboff (New York Univ., New York). Phys. Fluids, 5: 963-80(Aug. 1962).

The long-wavelength modes of excitation of a two-component plasma in a steady magnetic field are examined. Two linearized Boltzmann equations are given with collision terms that are coupled through the difference in temperatures and difference in velocities of the two gases. A formal means of classification of phenomena is described in terms of the nature of the roots about $k = 0$. Two types of behavior are uncovered: magnetohydrodynamic, which includes finite phase-speed phenomena near $k = 0$; and plasma-electromagnetic, which includes infinite-phase-speed phenomena near $k = 0$. The dissipative effects of collisions are included. In the limit of vanishing collision frequency, roots previously obtained are recaptured. The relevance of the pertinent domains are discussed and the complex interplay between the "fast" and "Alfvén" modes of magnetohydrodynamics and the plasma-magnetic modes of the plasma electromagnetic domain is demonstrated. Equations macroscopic in appearance are derived that include the effects of the initial configuration. In the limit of large collision frequency these equations reduce to standard forms. The dispersion of the Nth-order Larmor resonance, which includes the effect of the mass ratio, is given. (auth)

973 COAXIAL PLASMOID SOURCE OF SMALL ASPECT RATIO. David M. Wetstone (United Aircraft Corp., East Hartford, Conn.). Phys. Fluids, 5: 981-7 (Aug. 1962).

An annular source is described that approximates a one-dimensional geometry. Characteristic behavior is given, primarily for one set of operating parameters. A fast-acting valve injects 0.3 cc STP hydrogen, and capacitor firing is timed to permit operation in a particular mode. Photomultiplier data indicate a luminous front acceleration (for 40 cm) to a muzzle velocity of 103 cm/μsec; position probes yield 74 cm/μsec. The data appear to verify a hydromagnetic acceleration model, based on analog computation for a 0.06-μg slug (which is more than half the gas available in the annulus). The theoretically expected momentum is 6.2 dyne-sec; experiment yields 11.4 dyne-sec. Tentative number density and electron temperature are 3×10^{14}/cc and 3.6 ev, respectively. The latter datum is obtained by a double Langmuir probe. Efficiency considerations and the ion and electron collisional gyromagnetic parameters are outlined. (auth)

974 INSTABILITY OF A PLASMA COLUMN IN A LONGITUDINAL MAGNETIC FIELD. Roy R. Johnson and David A. Jerde (Boeing Scientific Research Labs., Seattle). Phys. Fluids, 5: 988-93(Aug. 1962).

The stability of a positive column in a longitudinal magnetic field is investigated by linearization of the macroscopic equations of motion and continuity for ions and electrons. Diffusion and magnetic field interaction terms are included in the ion equation of motion, and the equations are solved in a rigorous manner without any a priori assumptions regarding the form of the radial dependence of the perturbations of density and potential. In the one example calculated, for the helical instability, an important result is the existence of a finite perturbed potential at the wall radius. The boundary between stability and instability as a function of longitudinal electric and magnetic fields is shown graphically, along with the wavelength and frequency of the helical mode at the critical value of the magnetic field. (auth)

975 THEORY OF HIGH-IMPEDANCE RADIO-FREQUENCY-FORCE PLASMA DEVICES. H. W. Lorber (RCA Labs., Princeton, N. J.). Phys. Fluids, 5: 1003-9 (Aug. 1962).

It is shown that in the absence of a magneto-static field, in the case of high frequency and high impedance, the steady force exerted by an r-f field on a plasma is essentially proportional to the energy density gradient of the r-f electric field. As an example, a simple r-f plasma propulsion problem is solved, involving a plasma and an electrode structure, both of finite extent. The solution is consistent with experimental results, which show that a finite body of plasma whose density is greater than critical is pulled in the direction of increasing electric field whereas a plasma whose density is less than critical is pushed in the direction of decreasing electric field. (auth)

976 THEORY OF AN ELECTROSTATIC PROBE IN A STRONG MAGNETIC FIELD. [PART] II. Bruno Bertotti (Princeton Univ., N. J.). Phys. Fluids, 5: 1010-14(Aug. 1962).

A probe is considered in a magnetic field so strong as to impair collective transverse drifts. In this case, the charges supplied to the probe come mainly from a long tube of force whose radius is about one Larmor radius larger than the probe. It is assumed that there is acting a diffusion process, more efficient than ordinary drifts, which continuously exchanges particles between the inside of the tube of force and the rest of the plasma. A one-dimensional model of this process, leading to an integro-differential Poisson's equation, is investigated in the case of slow diffusion. The solution consists of a chargeless, slowly decaying potential, which describes the geometrical screening effect of the probe; while in the sheath an approximate boundary-layer solution matches with the probe's potential V_p. The asymptotic relation between the current collected and V_p is computed. This model may be suited to the case of diffusion caused by random wave fields. (auth)

977 LANGMUIR POTENTIAL ASSOCIATED WITH COUETTE FLOW OF VISCOUS PLASMA. Paul M. Chung (Aerospace Corp., El Segundo, Calif.). Phys. Fluids, 5: 1015-16(Aug. 1962).

The Couette flow of a plasma between two parallel plates is considered, in the case in which the ionization of the plasma is so weak as to have a negligible effect on the plasma's thermodynamic and transport properties. An electric field is assumed to exist between the parallel plates, and the electron and ion temperatures are assumed equal. (T.F.H.)

978 OBSERVATION OF PLASMA VORTEX RINGS. Daniel R. Wells (Princeton Univ., N. J. and Stevens Inst. of Tech., Hoboken, N. J.). Phys. Fluids, 5: 1016-18(Aug. 1962).

Conditions for the steady-state existence of magnetohydrodynamic vortex structures in a dense, inviscid, incompressible fluid are derived. Within the limits imposed by these conditions, a ring structure that is compatible with vortex structure is observed in the plasmoid produced by a θ-pinch plasma gun. (T.F.H.)

979 STARK BROADENING OF ISOLATED SPECTRAL LINES FROM HEAVY ELEMENTS IN A PLASMA. Hans R. Griem (Univ. of Maryland, College Park and U. S. Naval Research Lab., Washington, D. C.). Phys. Rev., 128: 515-23(Oct. 15, 1962).

The frequency distributions of neutral cesium and argon lines broadened by local fields of both electrons and ions in a plasma are calculated in the classical path approximation. The electron collisions are treated by an impact theory originally developed for neutral helium lines which takes into account deviations from adiabaticity. For the ion effects the adiabatic and in most instances also the quasistatic approximation can be used, if necessary, corrected for ion-ion correlations and Debye shielding. Atomic matrix elements are obtained with the Bates and Damgaard method and are checked against measured Stark coefficients. Stark broadening parameters are tabulated for the argon lines arising from 2p and 3p levels (Paschen's notation) and for the cesium lines in the series 6S-nP, 6P-nD with n up to 20, 6P-nS with n up to 15, and 5D-nF with n up to 10. Approximate formulas for total widths and shifts are suggested. For the widths an accuracy of 20% is indicated by the good agreement with experiments. Measured shifts are only available for argon. Here the calculated shifts tend to be 20% larger than the measured values. (auth)

980 HIGH-DENSITY CORRECTIONS IN PLASMA SPECTROSCOPY. Hans R. Griem (Univ. of Maryland, College Park and Naval Research Lab., Washington, D. C.). Phys. Rev., 128: 997-1003(Nov. 1, 1962).

The various relations between spectroscopically measured quantities and the temperature and density of a collision-dominated plasma in local thermal equilibrium are discussed. An internally consistent system of corrections is derived for Saha equations, partition functions, and equations of state on one hand, and line intensities, line profiles, continuum intensities, and optical refractivities. The errors due to remaining uncertainties in these corrections are shown to be usually below 1%. They are therefore negligible compared to those stemming from uncertainties in atomic theory (except for hydrogen or hydrogenic ions) and an order of magnitude smaller than was suggested by discrepancies between previously used corrections to ionization energies of atoms or ions in dense plasmas. (auth)

981 WAVE PROPAGATION ALONG A MAGNETIC FIELD IN A WARM PLASMA. P. M. Platzman and S. J. Buchsbaum (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 128: 1004-12(Nov. 1, 1962).

The steady-state properties of circularly polarized electromagnetic waves propagating along a static magnetic field in a warm uniform plasma are considered. The coupled Maxwell-Boltzmann equations (with ion dynamics neglected) are solved in the presence of short-range collisions. Expressions for the reflection and penetration of the waves into a semi-infinite plasma are obtained. These expressions are explicitly evaluated and discussed for a wide range of physical parameters. The temperature effects are large only (1) deep within the plasma and (2) near electron cyclotron resonance. The effect of temperature is to decrease reflection at frequencies just above the cyclotron frequency and to increase it for frequencies just below the cyclotron frequency. These effects arise from a resonance damping additional to collisional damping and from an upward shift in the effective cyclotron frequency of the hot electron. For frequencies just above the cyclotron frequency, the Poynting's vector in the plasma does not decrease monotonically with distance. The physical origin of this anomalous behavior is discussed. (auth)

982 SPIN DENSITY WAVES IN AN ELECTRON GAS. A. W. Overhauser (Ford Motor Co., Dearborn, Mich.). Phys. Rev., 128: 1437-52(Nov. 1, 1962).

It is shown rigorously that the paramagnetic state of an electron gas is never the Hartree-Fock ground state, even in the high-density—or weak-interaction—limit. The paramagnetic state is always unstable with respect to formation of a static spin density wave. The instability occurs for spin-density waves having a wave vector $Q \approx 2k_F$, the diameter of the Fermi sphere. It follows that the (Hartree-Fock) spin susceptibility of the paramagnetic state is not a monotonic decreasing function with increasing Q, but rather a function with a singularity near $Q = 2k_F$. Rather convincing experimental evidence that the antiferromagnetic ground state of chromium is a large-amplitude spin density wave state is summarized. A number of consequences of such states are discussed, including the problem of detecting them by neutron diffraction. (auth)

983 MAGNETORESISTANCE AND HALL EFFECT IN SEMICONDUCTORS WITH HOT ELECTRONS AND IN PLASMA. I. M. Dykman and E. I. Tolpygo (Semiconductor Inst., Kiev). Soviet Phys.-Solid State (English Transl.), 4: 659-67(Oct. 1962).

A semiconductor having high electron concentration is studied in an electric and magnetic field. The Hall coefficient, mobility, magnetoresistance, and electron temperature are calculated. An explanation is given of the behavior of these quantities, which appear during the transition of semiconductors from the region of impurity scattering to that of the lattice-scattering mechanism. The general results obtained, as well as those of the particular case considered, are also valid for plasma. (auth)

984 AXIAL-SYMMETRICAL OSCILLATIONS OF A PLASMA CYLINDER. L. S. Solovev. Zh. Tekhn. Fiz., 32: 934-47(Aug. 1962). (In Russian)

Nonlinear axially symmetric hydromagnetic oscillations of a plasma cylinder in an external magnetic field were analyzed, as well as axially symmetric wave propagation on the surface of a plasma cylinder with distributed current rotating around its axis. (R.V.J.)

985 THE INFLUENCE OF FINITE CONDUCTIVITY ON THE EQUILIBRIUM OF A SLIGHTLY CURVED PLASMA COLUMN. Yu. V. Vandakurov (Leningrad Inst. of Physics and Tech.). Zh. Tekhn. Fiz., 32: 948-57(Aug. 1962). (In Russian)

Studies were made of a stable, finite-conductance plasma cylinder with a curved axial line. Slightly twisted and helical plasma pinches are investigated. In the latter case the longitudinal current, having pressure equal to the plasma, is not able to force the plasma from the walls and the cross section pressure remains stable. An experiment with incompressible fluid for analyzing the disturbance of mass flux distributions inside the pinch is described. (tr-auth)

986 LOW-FREQUENCY PLASMA OSCILLATIONS IN MAGNETIC FIELD. V. D. Fedorchenko, B. N. Rutkevich, V. I. Muratov, and B. M. Chernyi. Zh. Tekhn. Fiz., 32: 958-66(Aug. 1962). (In Russian)

An electron beam with 100 kc oscillations, related to the high-frequency noise generated by an electron gun, was observed at 10^{-6} to 10^{-5} mm Hg pressure in magnetic fields and in electron injection magnetic traps. Depression of noise at the entrance of the gun reduced the oscillation amplitudes. An external high-frequency signal may replace the noise. Oscillations of 100 kc can also be excited by a 28 to 29 Mc signal. Plasma, produced by the beam in a gas-filled chamber, plays an important part in the excitation. It is postulated that the oscillations are excited by

irregular interactions of fields related to the noise in the plasma-beam system. (tr-auth)

987 PROPAGATION OF ELECTROMAGNETIC WAVES IN PLASMA TRANSVERSE TO EXTERNAL MAGNETIC FIELD. Yu. N. Dnestrovskii and D. P. Kostomarov. Zh. Vychislitel. Mat. i Mat. Fiz., 2: 97-106(1962). (In Russian)

Propagation of electromagnetic waves in a direction perpendicular to the external magnetic field was analyzed by means of approximations that establish the existence and uniqueness of a solution for a given problem. Solutions for a problem on wave excitation by side currents and a problem with initial conditions are constructed using integral transformations developed with data previously obtained. The developed solution for steady wave propagation transverse to the magnetic field indicates that in spite of complex dispersion equations, neither plasma nor electromagnetic field transfer energy to each other. (R.V.J.)

988 NUMERICAL INTEGRATION OF DIFFERENTIAL EQUATIONS FOR SHOCK WAVE STRUCTURE IN PLASMA. V. S. Imshennik. Zh. Vychislitel. Mat. i Mat. Fiz., 2: 206-16(1962). (In Russian)

The dissipation mechanism inside a shock front and the structure of the front in a strongly ionized medium are analyzed. The problem is reduced to the solution of four differential equations for determining two temperatures, the density, and the velocity of the waves at infinity. (R.V.J.)

989 ACCELERATION OF PLASMAS BY INDUCTIVELY GENERATED ELECTROMAGNETIC FIELDS. David Burke Miller. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1961. 231p.

Some aspects of the induction accelerator that can be derived theoretically are brought out. Isolated particle behavior within a cylindrical coil is studied. Charges gain energy from the azimuthally directed electric field; their paths are turned in the radial and axial directions by the magnetic field, and they eventually are ejected out the end of the coil. The exact paths of electrons and helium and argon ions under various field conditions are calculated by analog computer techniques, and from these calculations are obtained the velocity and angle that the ejected particles ultimately obtain. The quantitative dependence of ejection characteristics on initial position of the particle is found. The difference in behavior when the field period is much less than and much more than the time taken for the particle to be ejected from the accelerator is also noted. Induction acceleration of plasmas is theoretically considered, at first under the simplifying assumption that the coil is very long. This assumption eliminates radial magnetic field components and thrust in the axial direction, but it realistically treats the radial motion, which is an important energy-transferring process in the experimental device. The effect of self-fields (electric, from charge separation, and magnetic, from the gas current) on the radial motion is studied; even at quite low densities the particles are found to be bound to one another by these fields. The radial motion of such low-density plasmas is calculated. The radial dependences of magnetic field and current density within the ionized gas are shown to be approximated by Bessel functions. At high densities a skin current is shown to form, and to prevent penetration of the magnetic field into the interior of the plasma. For these high densities a "snowplow" analysis is used to calculate the radial motion of the plasma. The axial motion of plasma within a finite sized coil is considered. Qualitatively, it is argued that the majority of energy in axial motion arises from energy transmitted to the plasma by radial compression, and then converted to axial motion in the diverging magnetic nozzle. Characteristics of the flowing gas that can be obtained from observation of the advancing shock wave are brought out. Experiments using an induction accelerator are described. The accelerator is a 10 cm long by 10 cm in diameter, single-turn cylindrical coil driven by a 37.5 μfd capacitor bank. Capacitor voltages in the 5 to 10 kilovolt range are used. Ionization of the gas within the coil is accomplished partly by a high frequency preionization circuit and partly by the accelerator field itself. Data on helium and argon over the pressure range of 0.010 to 1.00 mm Hg are reported. Specifically, kinetic characteristics (radial and axial motion, momentum and energy) and internal structure (current and charge) of the accelerating ionized gas are studied. The measurements are correlated whenever possible with each other and with the theory. Axial velocity of the gas as it emerges from the coil is typically 0.5 to 10 cm per microsecond. Approximately 10 to 50 joules is transferred from the circuit to the gas; this represents up to 10 percent of the energy available in the magnetic field of the coil, and about half this transferred energy goes into directed motion of the gas. Ion temperatures, calculated from observations of the radial compression and axial shock, are in the 25,000 to 100,000°K range; electron temperature, measured for one pressure by an electric probe, is about one-third the concurrent ion temperature. Characteristics of a propulsion motor using the induction principle are estimated. (Dissertation Abstr., 22: No. 7, 1962.)

990 ELECTROMAGNETIC ACCELERATION OF A SHOCK HEATED PLASMA IN A CONSTANT AREA DUCT. Theodore Frederick Morse. Thesis, Evanston, Ill., Northwestern Univ., 1961. 103p.

Non-steady electromagnetic acceleration of a shock heated plasma is analyzed for the case of plane electrodes. The continuity, momentum, and entropy equations for a one-dimensional fluid mechanical system are formulated in terms of Lagrangian coordinates. This system of coordinates is used in order to take full advantage of the simple form of the Lagrangian entropy equation for an adiabatic process. The boundary conditions used in conjunction with the system of partial differential equations are the strong shock equations at the shock wave, and the equality of magnetic and fluid pressures at the surface of the current sheet. These boundary conditions are themselves functions of the unknown dependent variables of the system of equations. The energy source driving the current sheet into the undisturbed gas is taken to be a constant-voltage battery. This is chosen to approximate the current-time function that would be obtained from a set of capacitor banks arranged as a transmission line. The effect of plasma loading on the energy source is taken into consideration. In order to make these non-linear partial differential equations analytically tractable, a linear pressure gradient in the Lagrangian variable is assumed. This assumption enables simple functions to be constructed that described pressure, density, and particle position as functions of the independent variables of the problem. The positions of the shock wave and the current sheet are initially parabolic functions of time that gradually become hyperbolic as the steady state of the system is approached. Thus, the velocities of shock and current sheet are initially proportional to time, but as the driving current reaches its maximum value these velocities asymptotically approach constant values determined by the electromagnetic parameters of the system and initial gas conditions. (Dissertation Abstr., 22: No. 7, 1962.)

991 MICROWAVE MEASUREMENT OF QUIESCENT PLASMA ELECTRON DENSITY. William P. Ernst (Princeton Univ., N. J.). ISA Preprint No. 53.2.62. Pittsburgh, Instrument Society of America, 1962. (Prepublication Copy). 5p.

A system for measuring the electron density of a "steady-state" or quiescent plasma through the aid of microwave phase measuring techniques is explained. A single side-band "homodyne" method of measurement is used for phase changes up to 360° with a long time stability of ±2°. The system was adapted for use in the microwave millimeter range. (auth)

992 PLASMA HEATING AND CONFINING SYSTEM. (to U. S. Atomic Energy Commission). British Patent 906,979. Sept. 26, 1962.

A plasma injection, heating, and confining apparatus is designed in which much more plasma can be injected and concentrated. The apparatus has a field configuration with an entrance zone extending along a planar region rather than confined to a single linear axis. Two embodiments of the apparatus are described; in one, parallel linear plasma bodies are laterally accelerated into a containment field from opposite sides, while in the other, an annular plasma is accelerated radially inward to a containment field. (D.L.C.)

Shielding

993 (UNC-5017(Pt.A)) MINIMUM WEIGHT SHIELD SYNTHESIS. E. S. Troubetzkoy (United Nuclear Corp. Development Div., White Plains, N. Y.). Oct. 15, 1962. Contract AT(30-1)-2903. 53p.

A simple model for radiation production and attenuation in a spherical multilayer reactor-shield assembly is introduced. Variational methods are applied to this model to minimize the weight subject to given specifications on the dose at the outside of the shield and on the properties of shielding materials. The method provides guidance in the choice of the sequence of materials in the multilayer optimum shield, and gives equations which have to be satisfied by the radii at the boundaries of these layers. (auth)

994 NOMOGRAM FOR DETERMINING DISTANCE FROM SOURCE AND SHIELDING THICKNESS FOR GAMMA SHIELDING. František Khol (National Research Inst. for Materials and Tech. [Prague]). Jaderna Energie, 8: 205-7 (June 1962). (In Czech.)

The problem of gamma shielding to tolerance levels is treated frequently in the literature; and many tables, nomograms and mechanisms were devised for calculating gamma shielding. Unfortunately, much of this work was done for the old maximum allowable dose of 0.3 rem/week and cannot be simply corrected for the new allowable dose of 0.1 rem/week. Also, much of the work was done for a confined source of radiation. The nomogram of this paper is more flexible. It can factor in extended sources, shielding materials placed at an arbitrary distance from a source varying total distance from source to detector, and also gamma rays for a variety of source energies. The nomogram is constructed to handle various wall thicknesses of lead, iron or concrete. The wall may cover only a small fraction or about all of the distance between source and detector. (TTT)

Theoretical Physics

995 (ZFK-TPH-4) DIE LADUNGSUNABHÄNGIGKEIT DER KERNKRÄFTE UND IHRE BEDEUTUNG FÜR DIE UNTERSUCHUNG DER LEICHTEN KERNE. (The Charge Independence of Nuclear Forces and its Meaning for the Study of Light Nuclei) Karlheinz Mueller (Germany. Zentralinstitut für Kernphysik, Dresden). Aug. 1961. 36p.

A contribution to the proper understanding of the fundamental ideas connected with the concepts of the "isospin" is made by presenting them in a simple manner. A lecture held in the Nuclear Physics Colloquium of the German Academie of Sciences and a lecture given in the Theoretical Seminar of the ZfK Rossendorf are included to complete the formalism. (auth)

996 SUPPORT OF FIELD IN MOMENTUM SPACE. Derek W. Robinson (Institut für Theoretische Physik ETH, Zurich). Helv. Phys. Acta, 35: 403-13(1962). (In English)

The theory of a scalar field, defined under the assumptions of the Lorentz invariance, locality, absence of negative energy states, uniqueness, and cyclicity of the vacuum, is considered. It is proved that if the Fourier transform of the field in momentum space vanishes in the neighborhood of a space-like point, then the theory describes a generalized free field. (auth)

997 ENERGY-DENSITY RELATION FOR NUCLEAR MATTER. Franz Mohling (Univ. of Colorado, Boulder). Phys. Rev., 128: 1365-80(Nov. 1, 1962).

In most previous calculations of nuclear matter the energy has been calculated only at the equilibrium density, which density has been determined by a minimum condition. The author's theory of nuclear matter is applied to a study of the complete energy-density relation of nuclear matter, in the neighborhood of the equilibrium density. The emphasis here is not upon duplicating the accepted value for the equilibrium binding energy, but rather upon a study of the leading (diagonal) contribution of the quasi-particle interaction term $g_1(k_1k_2|k_3k_4)$, which is the matrix element of a reaction matrix G_1. It is shown that $g_1(k_1k_2|k_1k_2)$ must be evaluated partly by using observed nucleon-nucleon scattering phase shifts and partly by calculating the close-in behavior of the two-nucleon wave function, and that this second part receives a large contribution from the deuteron state. Curves are given for the dependence of $g_1(k_1k_2|k_1k_2)$ on the density and the center-of-mass momentum. It is also shown that $g_1(k_1k_2|k_1k_2)$ is sensitive to the size of the nucleon repulsive core, but not upon the character of the attraction, when agreement with scattering data has first been achieved. Finally, a comparison of $g_1(k_1k_2|k_1k_2)$ with the prediction of first-order perturbation theory is made. (auth)

998 ANALYTICITY IN ANGULAR MOMENTUM OF THE RELATIVISTIC MANY-CHANNEL S MATRIX FROM DISPERSION RELATIONS AND UNITARITY. A. O. Barut (Univ. of California, Berkeley). Phys. Rev., 128: 1959-63 (Nov. 15, 1962).

The analyticity of the scattering amplitude in angular momentum for N-coupled relativistic two-body channels is investigated on the basis of Mandelstam representation and unitarity. The problem of the proof of the analytic properties of the amplitude is reduced to the boundedness of a particular kernel involving the left-hand discontinuity of the amplitude. The behavior of the Regge trajectories at inelastic thresholds is determined. The results are extended to relativistic models with infinite-dimensional unitarity relation but without crossing symmetry such as the Bethe-Salpeter amplitude. The implications of the results to the exact S-matrix theory are also discussed. (auth)

999 INTRINSIC PARITY FROM THE S-MATRIX VIEWPOINT. Henry P. Stapp (Univ. of California,

Berkeley). Phys. Rev., 128: 1963-9(Nov. 15, 1962). (UCRL-10204)

The concept of intrinsic parity is developed as a construct of observables within the S-matrix framework, and ambiguities arising in more conventional approaches are avoided. It is shown that invariance of transition probabilities under spatial inversion implies the existence of a set of particle intrinsic parities that is real and unique to within a gauge transformation, provided all processes not forbidden by additive conservation laws do occur in nature. If certain of the conservation laws are multiplicative, then nonreal intrinsic parities are possible. The intrinsic parity of particle-antiparticle pairs is fixed by the general S-matrix postulates to be negative for fermions and positive for bosons, a result that parallels the one of field theory. (auth)

REACTOR TECHNOLOGY

General and Miscellaneous

Refer also to abstracts 14, 290, and 510.

1000 (ARF-4267-2) STUDIES OF REACTOR CONTAINMENT. Bi-Monthly Progress Report, July–August 1962. P. Lieberman and T. A. Zaker (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Contract AT(11-1)-578. 23p.

Work was continued on the generalized wave motion computer program for crushable shield analysis and design. Two problems for which the answers are known precisely were developed for testing the program. A routine was developed which traces all of the logical steps taken by the program in solving a problem. In shock impingement experiments on crushable shields, data were taken with wafer-type stress sensors designed for use in shock tubes in order to determine the Hugoniot and the unloading isentropes of balsa wood. (M.C.G.)

1001 (CEA-2175) LA DIGITALISATION DANS LE CONTROLE DES PILES ATOMIQUES. (Digitalization in Atomic Pile Control). J. Furet (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). 1962. 176p.

A survey is given of the general theorems of Boole's algebra and of sequence systems using D. A. Huffman's theory. Indications are also given concerning the setting-up and operation of digital computers and the principal codes used in digital techniques. It is shown how digitalization in atomic pile control makes it possible to use new techniques which promote greater working safety, a higher degree of centralization, and suppression of the linear elements. Examples are given of the application of these techniques to control, particularly with respect to the measurements of the neutronic power, the period, and the treatment of these data and the sequence automatisms. The advantage of using digital techniques in the shutdown channels is also examined. A review of the technology and the viability of the control devices used is included. (auth)

1002 (CRC-1095) AXIAL AND RADIAL DISTRIBUTION OF URANIUM AND PLUTONIUM ISOTOPES IN NRX ROD 45. M. Lounsbury, R. G. Hart, and R. W. Jones (Atomic Energy of Canada Ltd., Chalk River, Ont.). Sept. 1962. 27p. (AECL-1609)

Chemical and mass spectrometric measurements were made of Pu/U ratio, U^{235} depletion, and Pu isotopic composition at six axial positions in NRX Rod 45, corresponding to irradiation levels from 1300 to 6200 Mwd/t U. In addition, similar measurements were made of the radial variation of Pu/U ratio, U^{235} depletion, U^{236} production, and Pu isotopic composition at two axial positions in NRX Rod 45, corresponding to irradiation levels of 4750 and 6200 Mwd/t. (auth)

1003 (FXM-406) REACTOR DEADTIMES. J. R. Lamarsh and E. M. West (Pratt and Whitney Aircraft Div., United Aircraft Corp., [Hartford, Conn.]). Apr. 30, 1953. Contract [AT(11-1)-229]. 27p.

The deadtime of a reactor following shutdown after each mission was calculated. The effect on the deadtime of keeping the reactor critical at low power level following a mission was also computed. The results are presented as a set of curves valid for any reactor, once its over-ride characteristics are known. The poison buildup after any mission is discussed. The distinction between deadtime and the time before which the reactor can be restarted is outlined. (M.C.G.)

1004 (GAMD-3276) KRYPTON BACK DIFFUSION THROUGH GRAPHITE CLAD FUEL ELEMENTS. R. F. Turner and F. E. Vanslager (General Atomic Div., General Dynamics Corp., San Diego, Calif.). July 16, 1962. Contract AT(04-3)-314. 25p.

An investigation of gaseous back diffusion through various graphite cladding materials at reactor operating conditions was studied using Kr^{85} as a representative fission product. Results indicate that the effective back diffusion coefficient of graphite can be reduced by providing an inflow of He through the specimen wall. It is concluded that a material exhibiting a relatively flat curve of He permeability vs. mean He pressure is insensitive to the pressure differential across the specimen in back diffusion. (J.R.D.)

1005 (GEAP-4054) SUMMARY SAFEGUARDS REPORT FOR THE CRITICAL EXPERIMENT FACILITY, VALLECITOS ATOMIC LABORATORY. (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). July 1962. Includes AMENDMENT NO. 18 TO LICENSE APPLICATION FOR CRITICAL EXPERIMENT FACILITY. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Contract AT(04-3)-189. 145p.

Technical specifications and supporting data are presented for the Critical Experiment Facility modified for operation with two critical assemblies, the Thermal Critical Assembly and the Mixed Spectrum Critical Assembly. The procedural and instrumental control insuring safe operation of the facility is discussed. Descriptions of the site, the facility, and the critical assemblies are given. Operating standards and procedures are outlined. Organization and operation of the facility are described. Safeguards and hazards evaluations are included. (M.C.G.)

1006 (HW-60145) COMMENTS ON FAST EFFECT CALCULATIONS. G. D. Joanou (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 24, 1954. Contract AT(45-1)-1350. 7p.

Two methods for calculating the fast effect are discussed and described. Spinrad defines the fast effect as the number of neutrons making first collision with the moderator per neutron arising from thermal fission. Use of Hellstrand's resonance integral and the older formulation of the fast effect neglects captures in uranium-238 between the fission threshold and 100 kev. Hellstrand defines his expression for the resonance integral as including all captures between 100 kev and cadmium cut-off. The older formulation should be used when attempting to correlate individually measured lattice parameters since the value of the resonance escape probability when determined by neutron distributions in a fuel element will contain all fast captures in uranium-238 unless subtracted by the experimenter. (N.W.R.)

1007 (HW-73653(Rev.)) ZERO-DIMENSIONAL ANALYSIS OF SOME Pu–Al–H_2O ASSEMBLIES. P. L. Hofmann and G. J. Busselman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 11, 1962. Contract AT(45-1)-1350. 16p.

The applicability of the Westcott scheme (Westcott et al., Effective Cross Sections and Cd Ratios for the Neutron Spectra of Thermal Reactors, A/CONF 15, p.202, Canada) to the analysis of Pu–Al–H_2O assemblies is examined.

Methods for survey calculations are also suggested concerning reactor types not directly tractable by means of the Westcott cross section routines. (J.R.D.)

1008 (HW-SA-2677) PHYSICS OF PLUTONIUM IN THERMAL REACTORS. Paul F. Gast (General Electric Co. Hanford Atomics Products Operation, Richland, Wash.). [Sept. 11, 1962]. Contract AT(45-1)-1350. 32p.

In assessing the current state of the knowledge of the physics of plutonium as a thermal reactor fuel, a comparison was drawn with U^{235}. A review is presented of experimental work done with lattices using plutonium as a fuel. Computational methods developed thus far were chiefly for solving the problem of the change of concentration of various isotopes of the fuel as exposure proceeds. Nuclear data were collected and are presented. Results of integral experiments using lattices of plutonium fuels in light water, heavy water, and graphite are discussed. Results of burnup experiments are also described. (M.C.G.)

1009 (IDO-16689) SPERT IV HAZARDS SUMMARY REPORT. F. L. Bentzen and J. G. Crocker (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). July 7, 1961. Contract AT(10-1)-205. 67p.

Spert IV is a large pool-type experimental facility for reactor kinetic studies. These studies will include power excursion and instability tests for a variety of reactor designs. Since the Spert IV experimental program requires the performance of tests which will approach, and may exceed the threshold of reactor destruction, the probability of occurrence of the maximum possible accident is not negligible compared with that of other possible accidents. The maximum possible accident for this facility is considered to be a severe nuclear excursion which results in the destruction of the reactor building and the release of 100% of the accumulated fission product inventory of the atmosphere in a steam cloud. The fission product source assumed in the analysis of this accident is an upper limit in view of the nature of the tests to be performed and the heat removal capacity of the system. This postulated accident is independent of the details of core and control system design and is valid for all cores anticipated for use in the experimental program. The major hazards present in the operation of this facility, the precautions to be taken to reduce the probability of an accident, and the consequences of the maximum possible accident are discussed. It is concluded that the proposed method of operation will minimize the hazard to operating personnel, and that the site location will make possible the operation of the Spert IV facility without hazard to the general public. (auth)

1010 (IDO-16790) SPERT I DESTRUCTIVE TEST PROGRAM SAFETY ANALYSIS REPORT. A. H. Spano and R. W. Miller (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). June 15, 1962. Contract AT (10-1)-205. 173p.

The water-moderated core used for destructive experiments is mounted in the Spert I open-type reactor vessel, which has no provision for pressurization or forced coolant flow. The core is an array of highly enriched aluminum clad, plate-type fuel assemblies, using four blade-type, gang-operated control rods. Reactor transients are initiated at ambient temperature by step-insertions of reactivity, using a control rod which can be quickly ejected from the core. Following an initial series of static measurements to determine the basic reactor properties of the test core, a series of nondestructive, self-limiting power excursion tests was performed, which covered a reactor period range down to the point where minor fuel plate damage first occurred–approximately for a 10-msec period test. These tests provided power, temperature, and pressure data. Additional kinetic tests in the period region between 10 and 5 msec were completed to explore the region of limited core damage. Fuel plate damage results included plate distortion, cladding cracking, and fuel melting. These exploratory tests were valuable in revealing unexpected changes in the dependence of pressure, temperature, burst energy, and burst shape parameters on reactor period, although the dependence of peak power on reactor period was not significantly changed. An evaluation of hazards involved in conducting the 2-msec test, based on pessimistic assumptions regarding fission product release and weather conditions, indicates that with the procedural controls normally exercised in the conduct of any transient test at Spert and the special controls to be in effect during the destructive test series, no significant hazard to personnel or to the general public will be obtained. All nuclear operation is conducted remotely approximately ½ mile from the reactor building. Discussion is also given of the supervision and control of personnel during and after each destructive test, and of the plans for re-entry, cleanup, and restoration of the facility. (auth)

1011 (IDO-16791) PROCEEDINGS OF THE 1960 IDAHO CONFERENCE ON REACTOR KINETICS HELD AT SUN VALLEY, IDAHO, OCTOBER 12-14, 1960. J. C. Haire and G. O. Bright, eds. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). July 1962. Contract AT(10-1)-205. 371p.

Thirty papers are included on reactor kinetics with emphasis being placed on reactor safety and design considerations resulting from kinetic work. Information is presented on power excursion programs, reactor transfer function determination and application, reactor instability and thermal-hydraulic problems, and analytical methods in reactor kinetics. The accomplishments in the field and areas needing emphasis are discussed and summarized. Constructive suggestions are made on program direction and information dissemination. Separate abstracts were prepared for each paper. (N.W.R.)

1012 (IDO-16791(p.37-56) POWER EXCURSION STUDIES. Review Paper. F. Schroeder (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho).

Data and analytical work on various power excursion tests are summarized and discussed in order to show the present position and understanding of reactor kinetics under accident conditions. The results show that our understanding of plate-type, water-moderated systems of the low power research type seem to be in good shape. On the other hand, information on radiolytic gas formation and transient boiling phenomena is not understood too well. Data are primarily presented on safety experiments with SPERT I and KEWB; however, some information is presented on power excursion tests of Borax I, SPERT III, Triga, Treat, and Godiva. Results show that the problem of predicting the response of reactor systems is on a much firmer basis, even without knowing very much about details. (N.W.R.)

1013 (IDO-16791(p.57-63)) PRESENTATION OF KEWB PROGRAM. Marlin E. Remley (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

Power excursion tests on KEWB A and B cores were made in order to study the kinetic behavior and inherent shutdown behavior of the aqueous homogeneous reactor. The A core is of spherical shape and B of cylindrical shape. The tests were made to investigate the effect of geometry of the core on power excursions. Results are graphically

presented along with schematic drawings of the two cores. (N.W.R.)

1014 (IDO-16791(p.64-6)) PRESENTATION OF SPERT PROGRAM. Warren E. Nyer (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho).

Power excursion tests of SPERT I and III are discussed in regards to reactor safety. Emphasis is placed on kinetic behavior and shutdown characteristics. (N.W.R.)

1015 (IDO-16791(p.67-70)) PRESENTATION OF ORNL PROGRAM. [ELECTROMECHANICAL SAFETY APPLICATIONS TO BSR-II CORE IN SPERT]. E. P. Epler (Oak Ridge National Lab., Tenn.).

A comparison is made of electromechanical safety system and self shutdown tests of Bulk Shielding Facility (BSR-II) II core in SPERT I: A discussion is presented as to whether it pays to put in expensive shutdown devices when the self-shutdown effect affords protection for shorter periods than can be handled by the safeties. (N.W.R.)

1016 (IDO-16791(p.71-3)) PRESENTATION OF TRIGA PROGRAM. Ralph H. Stahl (General Atomic Div. General Dynamics Corp., San Diego, Calif.).

The shutdown characteristics of TRIGA Mark F are described and discussed. This reactor is water moderated and contains uranium-zirconium hydride fuel elements. The TRIGA Mark F has a water reflector and the TRIGA Mark-I a graphite reflector. The shutdown characteristics of the two reactors are illustrated and it is seen that both reactors behave the same. The fuel temperature coefficient is the mechanism of shutdown. (N.W.R.)

1017 (IDO-16791(p.74-7)) PRESENTATION OF GODIVA PROGRAM. T. F. Wimett (Los Alamos Scientific Lab., N. Mex.).

Power excursions of Godiva II are discussed. Results are presented from tests of sub-prompt-critical excursions in which the reactivity was increased stepwise to something under prompt critical, startup with no source, and fluctuations and wait time in the sub-prompt-critical region where the period was about 1.76 sec. (N.W.R.)

1018 (IDO-16791(p.78-85)) PRESENTATION OF TREAT PROGRAM. J. F. Boland (Argonne National Lab., Ill.).

Power excursion tests in TREAT are discussed. The meltdown of reactor fuel elements, especially EBR-II and Fermi types, in TREAT is reviewed along with metal-water reactions. (N.W.R.)

1019 (IDO-16791(p.107-17)) REVIEW OF REACTOR TRANSFER FUNCTION FIELD. J. A. Thie (McLain Rodger Associates, Downers Grove, Ill.).

Reactor transfer function determinations and applications are discussed. Information is given on experimental tests for determining transfer functions pointing out the successes and failures of these tests. The information is presented in such a manner as to apply to many reactor types. (N.W.R.)

1020 (IDO-16791(p.119-24)) A STATISTICAL STABILITY MONITOR. E. P. Gyftopoulos (Massachusetts Inst. of Tech., Cambridge).

The theory, operation, and performance of a statistical stability monitor based on the method of using externally applied statistical signals to get information about the transfer function of a reactor system are described. The method is to excite the system under investigation by an externally applied random input, measure the corresponding output, and cross correlate the input with the output. It turns out that the cross correlation of the input and output is equal to the convolution integral of the system function and the autocorrelation function of the input. The convolution integral reduces to the value of the system function. In other words the cross correlation function is equal to the system function. From the behavior of the system function, as viewed on the monitor screen, it is easily inferred whether the system is approaching instability. The cross correlation method has several advantages over other methods used for the measurement of the system function and these are discussed. (N.W.R.)

1021 (IDO-16791(p.125-32)) PRESENTATION OF BROOKHAVEN TRANSFER FUNCTION PROGRAM. H. J. C. Kouts (Brookhaven National Lab., Upton, N. Y.).

The cross correlation techniques for analyzing reactor transfer functions are described and discussed. The transfer functions are found in the frequency domain with the use of random inputs and statistical analysis techniques. Random signals are not fed in as square wave inputs, but are randomly generated by a radioactive source, the signals being integrated and then differentiated. The result is a nondescript function that wanders. Earlier work at Brookhaven on transfer function analyses is discussed. (N.W.R.)

1022 (IDO-16791(p.133-44)) PRESENTATION OF SPERT OSCILLATOR PROGRAM. A. A. Wasserman (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho).

The status of oscillator tests of SPERT-I is reported. The tests were made to determine the effect of reactivity amplitude on the measured transfer function at low power, to predict the upper limit of stable reactor power, to determine to what extent it is possible to use the transfer function measurements to predict measured transient behavior, to determine $1/\beta$, and to gain some experience with pile oscillators. Some of the basic information about the reactor and the oscillation experiment is reviewed. The pattern of the results is discussed along with future work. (N.W.R.)

1023 (IDO-16791(p.145-50)) PRESENTATION OF WESTINGHOUSE REACTOR TRANSFER FUNCTION PROGRAM. J. Nelson Grace (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Methods of predicting instability of the reactivity feedback loop in a reactor under boiling conditions are discussed. The frequency response method of spatial stability analysis and the MULE program for calculating model expansions is discussed along with other methods. Comparisons of measured and calculated closed loop transfer functions are in fair agreement. (N.W.R.)

1024 (IDO-16791(p.151-56)) DETERMINATION OF l^*/β BY PULSED NEUTRON METHOD. E. R. Silver (Oak Ridge National Lab., Tenn.).

Some measurements of l^*/β, the neutron generation time, using the pulsed neutron method are described and discussed. Results are presented for the BSR-I and BSR-II. Decay constant and $l^*/\gamma\beta$ values for an aluminum pool-type reactor at various reactivity values are also presented. (N.W.R.)

1025 (IDO-16791(p.157-9)) PRESENTATION OF NONLINEAR STABILITY PROBLEMS. F. Storrer (Atomic Power Development Associates, Inc., Detroit).

An attempt is made to extend the transfer function method to study the problem of nonlinear instability in reactors. The attempt is based on the fact that the transfer function method and the oscillator test are used to determine stability for small perturbations. The discussion is brief since the study is incomplete for large perturbation criteria. (N.W.R.)

1026 (IDO-16791(p.161-9)) HRT TRANSFER FUNCTION INFORMATION. P. R. Kasten (Oak Ridge National Lab., Tenn.).

A reactor-noise-analysis was performed to see if the shape of the transfer function was dependent upon factors which lead to fuel instabilities. In this study, the magnitude of the transfer function was investigated by autocorrelation. The results indicate that a change in the shape of the transfer function may give some indication of a change in operating conditions. Noise analysis permits one to obtain the shape of the transfer function rather readily, and so this information can be obtained during reactor operation. (N.W.R.)

1027 (IDO-16791(p.189-208)) THERMAL HYDRODYNAMIC INSTABILITY. Review Paper. N. Zuber (Ramo-Wooldridge Corp., [Los Angeles]).

The problem of two-phase flow instability is discussed and reviewed in order to obtain a better understanding of a water-cooled reactor with boiling. The problem can be divided into three separate problems: void problems (nucleation, bubble growth, and vapor removal), thermal problems (pressure variations, surface characteristics, and heat transfer correlations), and hydraulic problems (flow patterns, transient flow, pressure drop, and slip velocity). The effect of both nucleation properties and two-dimensional flow patterns on flow stability is discussed. The stabilizing effect of pressure increase is explained. An ultimate criterion for two-phase flow stability is presented which empirically relates the two-phase pressure drop, the nonboiling-length pressure drop, the total pressure drop, and the absolute pressure. (N.W.R.)

1028 (IDO-16791(p.209-29)) TRANSIENT BOILING EXPERIMENTS. Virgil E. Schrock (California. Univ., [Berkeley]).

An out-of-pile, bench-scale, transient boiling experiment, which is an extension of the Rosenthal and Miller work, is described and discussed. The study included the measurement of the steam volume developed as a function of time. The measurements were made over a range of pressures as high as those of interest in reactors and with flow imposed over the surface as well as with stagnant conditions. Results show that some success was attained in predicting when the first bubble appears. Thus, the rate of evaporation and the time at which nucleation first takes place can be estimated. (N.W.R.)

1029 (IDO-16791(p.230-33)) INSTABILITY PROBLEMS. Eric S. Beckjord (General Electric Co. Atomic Power Equipment Dept., [San Jose, Calif.]).

Hydraulic instability (two-phase flow oxcillations) of boiling water power reactors at high operating pressures and at steam qualities below 10% is discussed. Results show that the period of instability (flow pulsation) is always longer than the mean transit time of fluid across the vertical two-phase portion. This pulsation occurs under a wide range of conditions with regards to loop sub-cooling and quality. Another observation is that these oscillations can begin with no apparent external disturbance of the loop. The stability of two-phase flow systems may be accomplished by many parameters of geometry (downcomer restriction for instance), hydrodynamics (flow rate and pressure), and thermodynamics (heat input and inlet subcooling). (N.W.R.)

1030 (IDO-16791(p.234-5)) EXPERIMENTAL HYDRAULIC PROGRAMS AT ANL. Richard P. Anderson (Argonne National Lab., Ill.).

Experimental work being done at Argonne in the field of hydrodynamics is discussed. Stability experiments were made on the EBWR at 100 Mw and on the Borax-V boiling regions. The experiments were designed to show the effect of skewed flux distribution on the total extracted power from a given element. Other experiments were concerned with autocorrelation noise analysis on the void and flow traces from an instrumented hydrodynamic loop. Measurements of the transfer function (power-to-void) in a heated loop at pressures up to 1200 psi are being made. Stability measurements in a loop containing fast-response instrumentation are also being obtained. (N.W.R.)

1031 (IDO-16791(p.236-41)) PRESENTATION OF BETTIS PROGRAM [ON HYDRODYNAMIC INSTABILITY]. J. Nelson Grace (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Issued as WAPD-OP-11(Pt.II)

An attempt to simulate all reactivity feedback and hydrodynamic instability equations simultaneously by transient analysis using an analog model is discussed. The analog model included two channels: the nominal channel for reactivity feedback and a hot channel for showing hydrodynamic instabilities before the nominal channel oscillates. The hydrodynamic oscillations are determined in a reactor coolant channel having a constant applied pressure drop and constant heat flux. Curves are presented showing the result of a loss-of-coolant flow in a boiling reactor channel. The curves show axial flux shape effects, conservation of mass effects, and slip flow effects. (N.W.R.)

1032 (IDO-16791(p.242-5)) A MODEL FOR HYDRAULIC INSTABILITY. J. A. Fleck (California. Univ., Livermore. Lawrence Radiation Lab.).

A hydraulic model that provides a method for calculating boiling reactor dynamic behavior and gives some insight into the dynamics of natural convection flow, yielding possible mechanisms of instability, is described and discussed. The model does not enable the pinning down of the precise nature of boiling reactor instability; however, the model aids in understanding the hydraulic instability. The one-dimensional hydrodynamic model makes use of mass and energy conservation together with the principle that the sum of the pressure drops around the convection loop equals zero. A simple model of two-phase friction pressure drop is also used; namely, the increased friction in two-phase flow is assumed due to the reduction of flow area by steam. The analysis can be used to derive a system of ordinary differential equations involving inlet velocity, outlet velocity, outlet void fraction, and boiling length. The equations are integrated on a digital computer to obtain the flow behavior of the boiling reactor system. Results are presented for SPERT-I parameters. (N.W.R.)

1033 (IDO-16791(p.246-50)) DISCUSSION OF TWO TYPES OF REACTOR INSTABILITIES. J. Chernick (Brookhaven National Lab., Upton, N. Y.).

The problem of designing a reactor that is safe against instabilities caused by high-frequency oscillations due to delay in the negative temperature coefficient of the moderator and by low-frequency oscillations due to xenon is discussed. The results show that if a reactor is designed to be stable against space independent xenon oscillations, it may be expected that it will generally be stable against harmonics and therefore against spatial oscillations as well. (N.W.R.)

1034 (IDO-16791(p.251-4)) PRESENTATION OF RAMO-WOOLDRIDGE PROGRAM [ON HYDRAULIC INSTABILITY]. D. B. Langmuir (Ramo-Wooldridge Corp., [Los Angeles]).

The problem of hydraulic instability in reactors is discussed along with the status of the interpretations of trans-

fer function data. The discussion summarizes information already presented. (N.W.R.)

1035 (IDO-16791(p.263-82)) ANALYTICAL METHODS IN REACTOR KINETICS. Review Paper. A. F. Henry (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Issued as WAPD-OP-10.

The various theoretical approaches to reactor kinetic problems are reviewed. The review is split into four subject categories: the statistical part, the part having to do with the conventional kinetics equations, the part having to do with space-time problems, and the part having to do with space, over-all reactor plant description. The bibliography contains 117 references. (N.W.R.)

1036 (IDO-16791(p.283-8)) REVIEW OF SOME PROMPT CRITICAL ACCIDENTS. W. R. Stratton (Los Alamos Scientific Lab., N. Mex.).

Six prompt critical accidents that have occurred in this country are reviewed. These six represent the different types of incidents of the known 18. Almost all of the incidents seem to differ and there is usually not enough information to figure out what happened. (N.W.R.)

1037 (IDO-16791(p.289-92)) DEPENDENCE OF REACTOR BURST BEHAVIOR ON THE SPECIFIC SHUTDOWN LAW. S. G. Forbes (Ramo-Wooldridge Corp., [Los Angeles]).

Figure of merit equations for a reactor as far as safety is concerned are discussed. It is shown that in trying to set down even very elementary figures of merit on some very simple types of models that a very wide variation in the functional dependence on the parameters is found. Thus to design a reactor, one must have a general notion of the type of coupling that exists before any parameter adjustments can be formulated. A model is presented to show two different simplifications of a generalized model and how much they differ in their behavior. (N.W.R.)

1038 (IDO-16791(p.293-6)) DEVELOPMENTS IN REACTOR SAFETY AT ORNL. W. K. Ergen (Oak Ridge National Lab., Tenn.).

The main safety features of three reactors that ORNL is proposing to build in the foreseeable future are discussed with respect to features that are different from present reactors. The first reactor mentioned is the High-Flux Isotope Reactor (HFIR) which is being built to produce transplutonium isotopes. The light water-moderated, plate-type reactor fuel assembly contains a flux trap surrounded by two concentric, cylindrical fuel elements. The second is a Godiva-type reactor with higher power due to gamma phase uranium being stabilized by 10% molybdenum. The last is a molten-salt reactor (MSR). This reactor uses molten lithium beryllium fluoride containing zirconium and uranium fluorides as the working fluid. This graphite-moderated reactor is used to demonstrate that reactors of this type can be operated safely. (N.W.R.)

1039 (IDO-16791(p.297-301)) ANALYTICAL MODELS FOR BURST TRANSIENTS. S. O. Johnson (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Issued as WAPD-OP-11.

Analytical methods for calculating the response of reactors to the maximum credible accident are discussed. A three region conduction model governed by the normal heat conduction equation is used to explain safety calculations. This model investigates the importance of the various shutdown mechanisms. Reactivity contributions at peak power for 10-msec period SPERT-III transients are graphically presented as examples of safety calculations. (N.W.R.)

1040 (IDO-16791(p.302-5)) DISCUSSION OF EXTRACTION OF REACTIVITY FROM POWER TRACES AND EQUILIBRIUM BUBBLE SIZE ANALYSIS. E. R. Cohen (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

The procedures used to extract reactivity from the KEWB transient power traces are discussed, and the methods for analyzing equilibrium bubble size when a vapor bubble forms on a heated plate are described. The power trace in a KEWB transient is recorded on a strip chart using linear ion chambers. The logarithm of the power is evaluated along with a quadratic fit to the instantaneous inverse period (the derivative of the logarithm of the power). With this instantaneous effective inverse period, the kinetic equation is solved for the reactivity. The equilibrium bubble radius size is solved by specifying the wall temperature only at infinity, considering the conductivity of the base-plate, and knowing the heat flow in the water. (N.W.R.)

1041 (IDO-16791(p.306-8)) FAST REACTOR KINETICS. Harry H. Hummel (Argonne National Lab., Ill.).

The kinetic behavior of EBR-I and EBR-II is discussed with respect to experimental and theoretical calculations. It is shown that the behavior of the fast reactors tends to be fairly specifically tied to the particular idiosyncrasies of design, so that it is somewhat difficult to extrapolate behavior from one fast reactor to another. (N.W.R.)

1042 (JUL-54-RE) ABSCHIRMUNGSBERECHNUNG FUR DEN MATERIAL-PRÜFREAKTOR DIDO. (Shielding Calculations for the DIDO Materials Testing Reactor). O. Schaffer (Kernforschungsanlage, Julich, Germany). Jan. 12, 1960. 35p.

Shielding calculations are presented along with the results for the 10-Mw DIDO Materials Testing Reactor at Julich, Germany. The dosage outside the reactor shielding is approximately 0.73 mrem/hr at its weakest place. The calculations are broken down into the neutron fluxes for different power rates and for the different concrete compositions with respect to gamma capture. (N.W.R.)

1043 (LA-2733) A PRELIMINARY EVALUATION OF FAST OXIDE BREEDER REACTORS FOR SEA WATER CONVERSION. Alexander Sesonske and R. Philip Hammond (Los Alamos Scientific Lab., N. Mex.). Aug. 1962. Contract W-7405-eng-36. 80p.

In a reference concept for economic evaluation, a solid-oxide, fast breeder reactor is used to provide process steam for a multiple-stage flash evaporation water conversion plant. Water production costs are significantly reduced as the capacity is increased. At a capacity of one billion gallons per day, predicted costs range from 8 to 13 cents per thousand gallons, competitive with new large-scale conventional source projects. The generation of by-product electricity can lead to substantial reductions in these predicted costs. (auth)

1044 (NDA-2014-162) MATHEMATICAL FUNCTIONS RELATED TO DOPPLER COEFFICIENTS. J. Certaine and C. Klahr (Atomic Power Development Associates, Inc., Detroit and Nuclear Development Corp. of America. White Plains, N. Y.). Feb. 20, 1957. 9p.

Calculation of the Doppler temperature coefficient for fast reactors involves an energy average of certain ratios of U resonance parameters. These ratios are averaged over the assumed energy distribution of the resonance parameters. Expressions for the ratios are given and numerical results from their solution are tabulated. (J.R.D.)

1045 (NP-12101) FOURTH REPORT ON THE ACTIVITIES OF THE EUROPEAN NUCLEAR ENERGY

AGENCY. (European Nuclear Energy Agency, Paris). Sept. 1962. 87p.

Progress is reported on research and development conducted by members of the European Nuclear Energy Agency. Activities in joint undertakings concerning nuclear propulsion and heavy water are summarized along with Eurochemic, Halden, and Dragon developments. Cooperative efforts in nuclear research, reactor physics, nuclear data, use of radiations, and training are also summarized. Other activities are reported on public health, environmental radioactivity, nuclear ships, and reactor economics. (J.R.D.)

1046 (NP-12158) THE RESPONSE OF A NUCLEAR REACTOR TO A LINEAR INCREASE IN MULTIPLICATION. Research Bulletin No. 1. Lawrence A. Mink and Raymond L. Murray (North Carolina State Coll., Raleigh. School of Physical Sciences and Applied Mathematics). May 1962. 40p.

A generalized derivation of the kinetic equations of a nuclear reactor is given. Graphs are presented for the response of reactors with a typical lifetime to changes in multiplication that are linear in time. Curves are plotted for various ramp slopes, reactivities at cutoff, and effective delayed neutron fractions. The computer code used to calculate the neutron transients on a Remington-Rand 1105 computer is outlined. (auth)

1047 (ORNL-TM-387) AN ECONOMIC STUDY OF 1000 MEGAWATT HOMOGENEOUS REACTOR. R. H. Ball A. M. Hallene, and R. J. March (Oak Ridge National Lab., Tenn.). Aug. 19, 1952. Contract [W-7405-eng-26]. 105p.

Investigations of homogeneous reactors for simultaneous Pu and power production led to an economic study of a 1000-Mv installation. The plant considered would use 1.075% U in $UO_2SO_4-D_2O$ solution as fuel, be H_2O cooled, generate 1026 Mw of heat, 220,000 kw of electricity, and represent a capital investment of $\$1.69 \times 10^8$. (D.E.B.)

1048 (PRDC-TR-57) MONTHLY TECHNICAL REPORT [ON REACTOR DEVELOPMENT] MARCH 1962. (Power Reactor Development Co., Detroit). Contract AT (11-1)-476. 20p.

Construction and calibration of test equipment for emissivity measurements of borated graphite, carbon steel, and stainless steel are in progress. Further examination of the nitride layer on stainless steel nozzles is being conducted to determine the parameters of nitride layer integrity. In other work, a Na sampler was installed in the Fermi reactor with which four samples were taken from the reactor during the period. A preliminary investigation of cover gas contamination during reactor vessel maintenance is reported. Data are included on the thermal conductivity of graphite, and on oxidation of graphite in moist air at 500, 650, and 800°F. An investigation was conducted to determine analytical approaches for prediction of neutron streaming through gaps, ducts, and annuli in graphite shields. Other progress is reported in mechanical design, reactor systems, electrical systems and instrument development, and test operations. (J.R.D.)

1049 (SRO-73) HEAVY WATER POWER REACTOR PROGRAM MONTHLY PROGRESS REPORT, SEPTEMBER 1962. (Savannah River Operations Office, AEC). 10p.

Research and development progress is reported on AEC-AECL cooperative program, development of SAP, nondestructive tests of tubes, header and feeder piping fluid dynamics, zirconium technology, heat transfer at low heat flux, irradiation program, physics, metallurgy, engineering, Vallecitos Boiling Water Reactor, Heavy Water Components Test Reactor, and Carolinas-Virginia Tube Reactor. (M.C.G.)

1050 (TID-16785) NOTES FOR REACTOR DYNAMICS SEMINAR. R. P. Anderson (Argonne National Lab., Ill.). July 26, 1962. Contract [W-31-109-eng-38]. 81p.

The methods of calculating steady-state performance in two-phase systems and some of the current experimental investigations of two-phase flow are reviewed. Vapor volume fractions are discussed. Two-phase pressure drop correlations are reviewed. The computer program RECHOP, used to calculate recirculation in test loops and reactors, is described, along with a program being developed to eliminate the limitations of RECHOP. A two-year study was made of the dynamic behavior of two-phase natural circulation loops. A model was developed to predict loop performance. Eighty-three references are included. (M.C.G.)

1051 (TID-17026) EURATOM REACTOR FUEL MANAGEMENT PROGRAM QUARTERLY REPORT FOR APRIL–JUNE 1962. J. H. Crowley (Jackson and Moreland, Inc., Boston). Contract AT(30-1)-2874. 60p. (EURAEC-427)

Fuel cycle costs based on physics analysis were coördinated with capital costs and availability factors to determine economic effects of the following fuel management schemes on a dual-cycle boiling water reactor plant of SENN design: constant feed enrichment of 1.84% for out-in fuel moves for 3, 4, and 5 zones; variable feed enrichment within maximum controllability with 3, 4, and 5 zones for out-in fuel movements; one batch fueling for 1.84% feed enrichment; and variable feed enrichment within control limits for in-out fuel movements in 3, 4, and 5 zones. These cases apply to the original SENN core for banked rod operation. Although results of current studies indicate that, of the cases investigated, the maximum power flattening is obtained with the out-in method of management, substantial improvements in power flattening would be obtained by a more sophisticated checker-board type of refueling because of the flux depression caused by central location of fuel with maximum exposure. (auth)

1052 (WAPD-T-1468(Rev.)) U^{235} FISSION-PRODUCT POISON EXPERIMENTS. S. B. Gunst, J. C. Connor, E. D. McGarry, D. E. Conway, and S. Stein (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). June 1962. Contract AT-11-1-GEN-14. 15p.

Uranium-235 fission product poisoning is investigated in order to determine reactivity changes in irradiated reactor fuels. The methods developed for the fission product experiments are outlined. The results available indicate the depletion of uranium-235 and the fission product concentrations measured in the Reactivity Measurement Facility (RMF). (auth)

1053 (WCAP-908) A POWER SUPPLY FOR FRICTION GRIP, MAGNETIC JACK, NUCLEAR REACTOR CONTROL ROD DRIVE MECHANISM. S. M. Cantor (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). May 16, 1958. 18p.

A circuit designed for energizing and controlling twenty-four friction grip, magnetic jack type rod drive mechanisms is described. The circuit incorporates all desired control features while still remaining simple to operate. A considerable amount of thought was given to possible switching conditions, both manual and automatic, which might arise and would, if not anticipated in the circuit design, cause circuit malfunctions. (auth)

1054 (EURAEC-314) IMPROVING HEAT TRANSFER IN BOILING WATER NUCLEAR REACTORS. Quar-

terly Report No. 8, First Quarter, 1962. (Société Nationale d'Etude et de Construction de Moteurs d'Aviation. Division Atomiques, Suresnes, France). Apr. 1962. Work performed under United States–Euratom Joint Research and Development Program. 16p. A translation.

In hydrodynamic tests, difficulties caused by polarization of the electrodes used for detecting conduction bursts were avoided by changing the polarity between each test. Channel flow was analyzed by pressure recordings at 13, 35, and 57 cm from the entry. Data obtained in these measurements are presented graphically. Results of low pressure thermal tests are also included along with test operation information. Preparations for high pressure tests are described. (J.R.D.)

1055 NEUTRON TEMPERATURE IN FUEL ELEMENTS. G. B. Zorzoli (Laboratori CISE, Milan). Energia Nucl. (Milan), 9: 497-502(Sept. 1962). (In English)

A method for evaluating the neutron spectral shift from a Maxwellian distribution in fuel elements is described. The method, based upon a two-group calculation for accounting for two-temperature moderating media, evaluates the spectral hardening as an effect superimposed upon the solution from the two-group calculation. (auth)

1056 DESIGN CRITERIA, ENGINEERING FEATURES AND EXPERIMENTAL PROGRAM OF THE ECO REACTOR. P. Bonnaure, G. Casini, R. Cenerini, and F. Toselli (Euratom CCR, Ispra, Italy). Energia Nucl. (Milan), 9: 529-34(Sept. 1962). (In English)

The critical facility ECO is intended for buckling measurements of the ORGEL lattices by the progressive substitution method and for the evaluation of other important neutron parameters of lattices such as temperature coefficients, reactivity change as a function of the burn-up, microscopic parameters, and neutron spectrum. The criteria for the choice of the core parameters, some engineering features, and the experimental program of the ECO reactor are detailed. (auth)

1057 INVESTIGATION OF CONTINUOUS FLOW IN A NUCLEAR REACTOR HOLD UP TANK. Ole Berg (Danish Isotope Centre, Copenhagen). Ingeniøren, 4: 103-7(Sept. 1962). (In English)

The flow-through conditions in a hold-up tank for a water-cooled nuclear reactor were investigated in order to predict the effectiveness of the tank, i.e., its ability to reduce the N^{16} content in the cooling water before its passage from the reactor core to the outer cooling system. The factor f, expressing the reduction of the N^{16} concentration during the passage of the water through the hold up tank, was determined under various conditions by injecting Na^{24} into the cooling water at the inlet of the tank, measuring the Na^{24} concentration at the outlet as a function of time from injection, and treating mathematically the curves obtained in this way. A description of the general flow conditions as regards the degree of departure from piston flow is also given. In connection with the activity concentration measurements, a method for correction of the curves obtained for re-circulated material is given. (auth)

1058 NUCLEAR REACTOR SIMULATOR. Bohuslav Kuklik ([Czech Technical Univ.,] Prague). Jaderna Energie, 8: 301-7(1962). (In Czech.)

The model of a special analog computer, the so called simulator, is discussed. Two designs of a simulator are fully explained. In the first case the reactivity is given in the form of resistance values and absolute values are red on the simulator. The principle of the other design is the determination of deviations. Reactivity is given in the form of voltage. This is advantageous in the case of adding a real regulator to the simulator. But in this case the reactor simulator must be equipped with electronic multiplier. Modeling of primary and secondary cycles of a nuclear power station is also mentioned. The construction of a special simulator for primary and secondary cycles seems not to be the most advantageous solution. Better models may be reached on a universal differential analyzer. (auth)

1059 A METHOD OF MATHEMATICAL EVALUATION OF REACTOR CONTROL CIRCUIT. Frantisek Dráb. Jaderna Energie, 8: 308-14(1962). (In Czech.)

A reactor control system was designed predominantly by means of analogs that model the dynamics of the reactor and control elements. A practical calculation method, however, may be elaborated and used for the preparatory projection and evaluation of base characteristics of a control circuit. Such a method is demonstrated. Particular attention is paid to the method of determination of a simple transfer function. A harmonic balance method is also reported. The results, which are compared with the measurements on the reactor control-circuit analog, may be applied to other reactor control methods. (auth)

1060 AN ANALYSIS OF DYNAMIC CHARACTERISTICS OF PLUTONIUM- AND/OR THORIUM-RECYCLED REACTOR. II. ANALYTICAL APPROACH TO THE STABILITY. Itaru Michiyoshi and Kunihiko Uematsu (Kyoto Univ.). Nippon Genshiryoku Gakkaishi, 4: 600-7(Sept. 1962). (In English)

An analytical approach to the stability of linear and nonlinear reactor kinetic equations is applied to the cases of constant power removal and Newton's law of cooling model. From the comparison of the results between linear and nonlinear analyses, stability criteria are obtained for each of these models, in terms of the temperature coefficient and other thermal properties of the reactor materials. It is proved that the delayed neutron fraction does not have any effect on the stability criterion or on the equilibrium values of power and temperature. The delayed neutron fraction does, however, reduce the maximum power and affect the behavior in approaches to equilibrium values. (auth)

1061 ON THE THERMODYNAMIC ELEMENTS OF REACTOR COOLING. G. Bueki (Univ. of Budapest). Periodica Polytech., 6: 129-45(1962). (In German)

From the temperature diagrams of reactors and the working materials the mean temperature can be determined accordingly by the power calculations and energy considerations which vary from one to another. The combination of the nuclear physics and thermodynamics processes in the reactor and in the work processes make difficult the optimal solution which the various objectives can have. As an example the choice of the coolant type and the determination of the favorable coolant exit temperature were considered with the results that a new way was suggested for the operation of reactors in which by decreasing the charge an increase in the coolant temperature is provided for. By this means the fissionable material is also well utilized by partial charge and the efficiency of the cyclic process is improved. This increases the price of the equipment for the secondary cycle. It also results in dependence of the charge on a limiting value under which the increase of the original parameter is no longer economical. (tr-auth)

1062 MEASUREMENT OF THERMAL STRESSES WITHIN AN EXPERIMENTAL NUCLEAR-REACTOR VESSEL HEAD. G. A. Brewer and J. D. Ingham (Brewer Engineering Labs., Inc., Marion, Mass.). Proc. Soc. Exptl. Stress Anal., 19: No. 1, 9-14(Jan. 1962).

Certain tests and techniques employed in measuring stresses within an experimental nuclear-reactor head of unusual design are described. The incorporation of certain desired design features necessitated that the head be extremely thick. Due to the thickness and its complex geometry, it was considered desirable to determine stress distribution within the head under conditions of steady-state pressure combined with rapid heating and cooling transients within the reactor, in order to determine safe limits for the operation of the head. The technique employed in measuring thermal stresses in the interior of the head, under simulated operating conditions of steady-state pressure and temperature transients, is described and results given. (auth)

1063 INVESTIGATING REACTOR BEHAVIOUR USING CONVENTIONAL SIGNS OF CONTROL TECHNIQUE. Karl Peuster (Rheinisch-Westfälischen Elektrizitätswerke A. G., Essen). VDI (Ver. Deutr. Ingr.) Z., 104: 1496-1501(Oct. 11, 1962). (In German)

The use of conventional symbols of control engineering in investigations of reactor behavior is discussed. A control function diagram can be regarded as a shortened set-up diagram for analog computing. In derivations of basic features of reactors, the relation between the control function diagram, the analog computer diagram, and the functional equation is outlined. (auth)

1064 ZIRCALOY-CLAD UO_2 FUEL: ITS PRESENT LIMITATION AND FUTURE POTENTIAL. J. A. L. Robertson (Atomic Energy of Canada Ltd., Chalk River, Ont.). Preprint. [Ottawa], Canadian Nuclear Association, 1962. 14p.

It has been recognized that UO_2 fuel elements fail only when their sheaths fail. The following aspects of performance that could lead to sheath instability or damage are discussed: melting of the UO_2; collapse of the sheath (control of clearance left between fuel and sheath on assembly); circumferential ridges in the sheath; filling gas; release of gaseous fission products; sheath defects and hydriding. There is evidence that a maximum heat rating of 500 w/cm length of fuel is feasible. (A.G.W.)

1065 PRINCIPAL NUCLEAR ACHIEVEMENTS IN BELGIUM. J. Van der Spek (Societe Belge pour l'Industrie Nucléaire, Brussels). Preprint. [Ottawa], Canadian Nuclear Association, 1962. 12p.

The essential purpose of the Belgian nuclear industry is not to produce energy at any rate, but to manufacture nuclear reactors and equipment for Belgium and foreign countries. Emphasis has been placed on breeder reactors and Pu technology. Contributions of both government and industry to the Belgian nuclear industry are outlined. Major achievements are listed as follows: (1) laboratories in Mol for study of the use of Pu as a fuel in thermal reactors; (2) the "Vulcain" reactor employing a variable moderation concept; (3) the SENA power plant being built on the river Meuse near Givet. Projects in which Belgium cooperates with other countries are reviewed. (A.G.W.)

1066 NUCLEAR REACTOR BUBBLE CONTROL. A. C. Whittier (Canadian General Electric Co., Ltd., Peterborough, Ont.). Preprint. [Ottawa], Canadian Nuclear Association, 1962. 11p.

Control of the reactivity of a nuclear reactor is achieved by altering the number of neutrons per fission which are available to carry on the reaction. Normally this is done by either absorbing excess neutrons in control rods or by allowing them to leak out of the system by decreasing the size of the reactor. A new method of reactor control is proposed—that of altering the reactivity by reducing the effective density of the moderator. Density reduction is obtained by bubbling a gas through the moderator. Advantages of the bubble control system are increased fuel burnup, increased power output, and simplicity of the control system. (auth)

1067 INSTRUMENT SYSTEMS FOR NUCLEAR ACTIVITY MONITORING AT THE HEAVY WATER COMPONENTS TEST REACTOR. Bruce G. Kitchen (E. I. du Pont de Nemours and Co., Aiken, S. C.). ISA Preprint No. 52.1.62. Pittsburgh, Instrument Society of America, 1962. 8p.

The Heavy Water Components Test Reactor employs activity-monitoring instrument systems for personnel protection and for reactor control and safety. The systems are described as to design intent, function, and operation. (auth)

1068 DEVELOPMENTAL SCANNING-TYPE REACTOR FUEL FAILURE MONITOR. J. L. Stringer and E. M. Sheen (General Electric Co., Richland, Wash.). ISA Reprint No. 52.2.62. Pittsburgh, Instrument Society of America, 1962. 10p.

Development was carried out on an approach to the monitoring problem in an effort to provide a reliable and sensitive system. The method developed uses two scintillation detectors to monitor one hundred sample channels arranged on the periphery of a circle. One detector, which is rotated past the samples, monitors the gross activity of each sample every five seconds, and electronic circuits and scanner were designed in a manner to simulate nearly continuous monitoring. The second detector used pulse height discrimination methods to monitor gamma rays from each sample within particular energy bands. The monitored energies are selected for optimum signal-to-background ratio. This detector routinely monitors each sample once every forty minutes and can be rapidly moved to monitor any selected sample continuously. Problems in valving sample flows or in switching electrical signals are avoided by the method of rotating the shielded detectors past a circular array of effluent sample chambers. Circuits were developed to compensate for changes in the background radiation level of the effluent resulting from changes in reactor operation. Other development circuits display the monitor signal for the operator, automatically actuate warning alarms, and automatically check the monitor for proper operation with a radioactive calibration source. (auth)

1069 THE MEASUREMENT OF DYNAMIC NUCLEAR REACTOR PARAMETERS BY METHODS OF STOCHASTIC PROCESSES. Robert William Albrecht. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1961. 129p.

Mathematical models are developed for the statistical variance/mean of the number of neutrons detected in an interval of time in a point, unloaded reactor. An experiment that measures variance/mean for counting times between one millisecond and ten seconds is performed. Comparisons between the mathematical model and the experiment are made. The results show that the delayed neutron contribution to the measured variance/mean is significant, that these delayed neutron effects should be accounted for when using this method for determination of prompt neutron lifetime, and that these techniques may be used to measure dynamic reactor parameters without an external perturbation. The prompt neutron lifetime of the Ford Reactor is measured. Delayed neutrons make a significant contribution to the measured quantities. (Dissertation Abstr., 22: No. 7, 1962.)

1070 REACTOR SAFETY AND HAZARDS EVALUATION TECHNIQUES. VOL. I. Proceedings of the Sympo-

sium on Reactor Safety and Hazards Evaluation Techniques Held in Vienna, May 14-18, 1962. (International Atomic Energy Agency, Vienna). Proceedings Series. Aug. 1962. 544p. (STI/PUB/57(Vol. I)). $10.00; 210s; NF 40; DM 35 (IAEA).

A total of 38 papers is included. Separate abstracts were prepared for 12 papers, and a total of 20 papers was previously abstracted in NSA. (J.R.D.)

1071 REACTOR SAFETY AND CONSTRUCTION PRACTICE. P. A. Morris (U. S. Atomic Energy Commission, Washington, D. C.). p.193-205 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 1." Vienna, International Atomic Energy Agency, 1962. (In English)

The relation of construction practice to reactor safety is discussed in terms of past and current United States experience and thinking. Examples and illustrations of this relation are given with respect to power, test, and research reactors and critical facilities. Topics discussed include selection of materials, quality control, specification of construction techniques, workmanship, acceptance checking and functional testing of systems and components, and inspection methods and results. (auth)

1072 SAFETY ASPECTS OF OPERATIONAL EXPERIENCE WITH THE CALDER HALL NUCLEAR POWER PLANT. V. R. Goodwin and T. N. Marsham (United Kingdom Atomic Energy Authority, Windscale and Calder Works, Sellafield, Eng.). p.207-18 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 1." Vienna, International Atomic Energy Agency, 1962. (In English)

Reactor safety and operational methods are discussed in the light of 5 years operation at Calder Hall. Plant commissioning is examined, and the value of plant operation limits is shown. Monitoring of reactor material radiation damage is discussed along with the behavior of protective circuits and control rods. Routine monitoring for personnel protection is also reviewed. (J.R.D.)

1073 SOME SAFETY ASPECTS IN REACTOR DESIGN. A. Birkhofer and H. Karwat (Technische Uberwachungs-Vereine Bayern, Munich). p.271-85 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 1." Vienna, International Atomic Energy Agency, 1962. (In English)

The first, and for all reactors most important, barrier for the escape of radioactive fission products is the fuel-element clad. Considering the safety of the reactor during normal operation and in the case of an accident, a conservative designed fuel clad can be considered as a kind of first containment. From the requirement for a sufficient burn-out safety margin up to the problem of the embrittlement of cladding materials, the questions arising in reactor design are the same as in safety considerations concerning fuel elements. Problems in the determination of burn-out heat fluxes for liquid-cooled power reactors, fission gas build-up for ceramic fuel elements, thermal conductivity of ceramic fuels at high temperatures, and questions on hazards are discussed. Conclusions are made which can be obtained if the fuel element clad be considered as the first containment in some accident analyses. There are also consequences for the operation of steam turbines with primary steam outside the gas-tight reactor building. (auth)

1074 DETERMINATION OF REACTOR LOCATION AND REQUIREMENTS FOR THE PRESSURE SHELL ON THE BASIS OF THE MAXIMUM CREDIBLE ACCIDENT AND THE POPULATION DOSE LIMIT. G. Blaesser and K. Wirtz (Kernforschungszentrum Karlsruhe, Ger.). p.339-47 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 1." Vienna, International Atomic Energy Agency, 1962. (In English)

The consequences of the maximum credible account (MCA) are discussed for various filtering procedures and different values for the tightness of the pressure shell in terms of the doses received at various distances from the reactor. The legal limits for the population dose then allow the definition of an exclusion area. The size of this exclusion area depends on the type of MCA and on the layout of the pressure shell. Thus, from nuclear points of view, site and building may be chosen individually for any reactor. (auth)

1075 PRINCIPLES AND PRACTICES IN "CONSEQUENCES LIMITING" SAFEGUARDS IN FACILITY DESIGN. W. E. Johnson (Westinghouse Electric Corp., Pittsburgh). p.349-61 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 1." Vienna, International Atomic Energy Agency, 1962. (In English)

A review of safeguards in the design of reactor facilities in the United States is presented, which indicates that reliable safeguards can be provided to protect the public. Included in this review are such design features as multiple barrier containment, ducted containment, pressure suppression, missile and shock wave protection, and various methods of post-accident filtration and scrubbing of the containment atmosphere. The evolution of such design features is traced to the present time and includes discussion of practices being considered in reactor facilities in the advanced planning stage. The comparative effectiveness of these techniques and the role they must play in the advancement of the nuclear power industry is discussed. (auth)

1076 THE CONTAINMENT OF HIGH TEMPERATURE REACTORS. J. Allen (OECD, Atomic Energy Establishment, Winfrith, Dorset, Eng.) and H. W. Schmidt. p.363-77 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 1." Vienna, International Atomic Energy Agency, 1962. (In English)

Requirements for containment of the Dragon Reactor are discussed. A system of multiple containment was adopted for this reactor. This scheme is described and compared with alternate designs. (J.R.D.)

1077 UNDERGROUND LOCATION OF NUCLEAR REACTORS. E. Binggeli, P. Verstraete, and A. Sutter. p.379-400 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 1." Vienna, International Atomic Energy Agency, 1962. (In French)

The requirement of an extended exclusion area imposed upon many large, above-ground nuclear plants becomes impractical and unacceptable in densely populated countries with high land values. Under these circumstances effective and highly reliable containment must be provided to compensate for the absence of distance. Rock caverns offer interesting possibilities for such containment. Not only can they withstand much higher pressure loads than above-ground steel constructions, but they are also relatively invulnerable to missiles from within and damaging events from without the cavern. Moreover, such leakage as does occur from the contained volume cannot be dispersed rapidly over a large surrounding area. In rock caverns the problem of post-accident environment radiation shielding becomes irrevelant. The gas flow through a porous medium, the progression of gases by diffusion in the rock, and the time dependent leak tightness of a rock chamber are investigated. The contamination engendered in the rock, in the ground water, and that released to the atmosphere is considered, and it is shown that under appropriate conditions this contamination can be kept low enough to impose no undue risk on the neighboring population. (auth)

1078 A COMPARISON OF THE TECHNOLOGY AND ECONOMICS OF VARIOUS TYPES OF SAFETY VESSEL.

C. Segot and R. Mattéra (Centre d'Etudes Nucléaires, Saclay, France). p.401-11 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 1." Vienna, International Atomic Energy Agency, 1962. (In French)

A technological and economic comparison of reactor containment schemes was made in France. Results are presented for the standard steel containment vessel and for a prestressed concrete vessel. (J.R.D.)

1079 STUDIES ON THE SAFETY SHIELDING OF "RAPSODIE." G. A. V. Drevon, M. Gelée, and R. Wustner (Commissariat à l'Énergie Atomique, Paris). p.413-20 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 1." Vienna, International Atomic Energy Agency, 1962. (In French)

The role and general design of the safety shielding of "Rapsodie" are summarized. Details of a study of the effects of the maximum credible accident are provided. Data are given on the leaktight metal shielding and arrangements for coping with possible leaks. (auth)

1080 AN ATTEMPT TO PREDICT RELIABILITY OF ELECTRONIC INSTRUMENTS AND REDUNDANT SYSTEMS. J. Rasmussen and P. Timmermann (Forsogsanlaeg Riso, Roskilde, Denmark). p.433-48 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 1." Vienna, International Atomic Energy Agency, 1962. (In English)

Failures in reactor safety instrumentation may cause economic losses from unwanted reactor shut-downs or reduce safety to an unacceptable level. Improvements are possible by the use of more reliable components, fail-to-safe principles, regular test procedures, and redundant systems. Prediction of reliability is of importance in design and analysis, as the reduction of shut-downs and the increase of safety are often conflicting. The basis for an optimum system is an evaluation of the properties of the instrumentation to which the probability and cost of accidents can be applied. The instrument or system performance is described by the rate of reactor shut-downs from safe failures, and the fraction of time in which unsafe failures exist. The effect of repair and test during operation is considered. The performance of various systems can be compared without exact information on failure rates. When instruments of different design have to be compared, or more accurate estimates of expected failure rates are wanted, more detailed information is necessary. If the instruments have been used during a reasonably long period, prediction can be based on actual failure data. Such data, representing a collection over two years, are presented and their possible use for prediction is discussed. When field data are not available, prediction has to be based on component failure data. The work is only in an initial stage and has to be followed by statistical tests on actual instrument failure data. (auth)

1081 DESIGN PRINCIPLE OF A SHUT-DOWN ROD. H. J. Kraus (Kernreaktor Bau- und Betriebsgesellschaft, Karlsruhe, Ger.). p.491-9 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 1." Vienna, International Atomic Energy Agency, 1962. (In English)

The mechanical components applied should be chosen exclusively under the aspect of security. The size of the essential construction units is determined by the lifting element. The application of a ball-bearing screw, which even without lubrication has an efficiency of more than 90%, provides a small drive with a motor of about 20 w as well as a telescope-like space-saving design of the whole rod. As a combining element between the lifting mechanism and the absorber, a magnet is provided. For indicating special absorber positions, a solution is discussed which is compatible with respect to design and safety. By this method no additional construction elements are needed inside the rod. The position of the maximum negative reactivity effect of an absorber should be determined and indicated by a procedure independent of already existing indications. The suggested pneumatic design according to the nozzle flapper system also permits installation of the parts, which must be serviced, outside the reactor shielding. The expenses for the suggested monitoring produced are very much higher than for the installation of limit switches. The decisive advantage, however, is that in neither case do components subject to wear have to be installed inside the rod. In the design of a shut-down rod, the fact that only a simple device complying with all safety considerations can be used as a positioning element of safety or reactor control systems is worthy of detailed consideration. (auth)

1082 CONTROL AND SAFETY IN THE OPERATION OF THE NRX AND NRU REACTORS. J. H. Collins and D. C. Breckon (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.501-23 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 1." Vienna, International Atomic Energy Agency, 1962. (In English)

Safety in reactor operations is achieved through review and development of reactor control systems together with the exercise of sound administrative controls. At Chalk River, the control and safety systems of the NRX reactor were developed over the 14-year history of the reactor to provide safer and more reliable operation. The original 18 BC shut-off rods were replaced by six electrically-operated rods of greater reliability and a simultaneous dump of the heavy-water moderator. Each device can shut down the reactor independently. As reactor technology has advanced, so have administrative controls. It is essential to have well-established responsibilities through a well-knit organization with personnel trained in sound policies and procedures. In both NRX and NRU, system modifications are governed by design procedures, field work by work permits, entry to limited access areas through interlock systems, operation of valves through valve slips and flowsheets. Where feasible, check-off systems are used to verify field operations. Scheduled equipment checks, made possible at power by the two-out-of-three coincidence system, permit a continual assessment of the reactor systems. When associated with well-established maintenance procedures, they enhance the reliability and safety of the reactor. (auth)

1083 REACTOR SAFETY AND HAZARDS EVALUATION TECHNIQUES. VOL. II. Proceedings of the Symposium on Reactor Safety and Hazards Evaluation Techniques Held in Vienna, May 14-18, 1962. (International Atomic Energy Agency, Vienna). Proceedings Series. Aug. 1962. 548p. (STI/PUB/57(Vol. II)). $10.00; 210s; NF 40; DM 35 (IAEA).

A total of 37 papers is included. Separate abstracts were prepared for 16 of the papers. Fifteen of the papers were previously abstracted in NSA. (J.R.D.)

1084 LICENSING AND INSPECTION OF NUCLEAR INSTALLATIONS IN THE UNITED KINGDOM. F. R. Charlesworth and T. Griffiths (Ministry of Power, London). p. 15-30 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 2." Vienna, International Atomic Energy Agency, 1962. (In English)

In 1955 the Government announced its program for the development of nuclear power in the United Kingdom. Later, in 1958, it announced its intentions with regard to the regulation of these nuclear installations. The principal aim was to ensure the protection of the public by instituting a system

of licensing and inspection of all nuclear installations that could give rise to radiation hazards outside the boundaries of the establishment. The Nuclear Installations (Licensing and Insurance) Act, 1959, came into force on 1 April of that year. This Act enables the Minister of Power (In Scotland the Secretary of State) to license and inspect any reactor or such installations as may be prescribed by regulations and to attach any conditions to a license as they appear to be necessary. Matters covered by the license include the securing and maintaining of radiation detection equipment, measures for dealing with emergencies, the handling of radioactive materials and fuel elements in particular, as well as general matters relating to siting, design, construction, operation and maintenance of the installation. Requirements and procedures in respect of these matters are described. Among the types of installation so far covered, or proposed to be covered, by the Act, are the power generating stations run by the Central Electricity Generating Board, high and low power research reactors run by private industry or universities, plants manufacturing fuel elements or otherwise handling enriched U or Pu where a criticality accident may be considered possible, and plants handling large quantities of radioactive isotopes where a fire or some other accident could give rise to a hazard outside the boundary of the establishment. Exceptions to the Act include other Government Departments or the Armed Services and the United Kingdom Atomic Energy Authority. The latter is covered by other legislation, notably the Atomic Energy Authority Act, 1954, which sets the responsibility upon the UKAEA for preventing damage or injury to property or persons outside Authority establishments, the Authority to be liable for such damage or injury whether negligent or not. Owners of licensed sites in the UK have similar obligations and responsibilities and have to provide suitable insurance cover as a condition of their license. To carry out the terms of the Act, the Minister of Power has an inspectorate headed by a Chief Inspector of Nuclear Installations and containing a number of inspectors with professional qualifications in various fields of nuclear studies. To assist the Minister and his Inspectorate, a number of advisory bodies were instituted with a wide range of interests represented. In the execution of their office it is frequently necessary to take into account regulations promulgated by other Government departments, for example, the Ministry of Labor or the Ministry of Agriculture and Fisheries, and close liaison with these departments is maintained. It is also necessary for liaison to be made with outside interests such as the UKAEA, Lloyds Insurance etc. who may undertake on behalf of the Inspectorate of Nuclear Installations some of the more specialized examinations. (auth)

1085 A BIOLOGICAL CONSIDERATION ON VARIABILITY OF DOSES RECEIVED BY EXPOSURE TO RADIOACTIVE AEROSOL RELEASED IN A HYPOTHETICAL BIG REACTOR ACCIDENT AND EVALUATION OF EXPOSURE HAZARD. M. Suzuki (International Atomic Energy Agency, Vienna). p.85-108 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 2." Vienna, International Atomic Energy Agency, 1962. (In English)

The dose received by a man encountering a radioactive cloud released by a hypothetical reactor accident varies greatly. The doses from external exposure to radioactive clouds and by inhalation of radioactive aerosol were calculated using assumptions concerning characteristics of aerosol, condition of exposure, and biological factors. Results showed that the doses accumulated vary greatly in different parts of the body. Factors of importance are components of fission products released, exposure conditions, and particle size of the aerosol. Biological evaluations were made on the variability of the doses by setting up criteria on tentative permissible emergency doses. Four kinds of fission products release and two exposure conditions were assumed. Calculations of dose were made on five different parts of the body assumed to be critical. It is clear that in cases of volatile fission product release, the thyroid is always considered as a critical organ, provided that the proposed permissible unit is reasonable. In cases of total fission product release, lung and bone would be the most critical organs because many hazardous long-life fission products are involved in the release. The study also shows that total fission product release is usually more hazardous than volatile fission product release, as far as safety of the public is concerned. The worst case could be total fission product release with small particle size. Since the variation is so significant in biological sense, it should be emphasized that the statement of total exposure in terms of curie or rad alone is of dubious value for the evaluation of hazards of this kind. (auth)

1086 SAFETY PROBLEMS OF NATURAL URANIUM GRAPHITE-MODERATED GAS-COOLED POWER REACTORS. J. Bourgeois (Commissariat à l'Énergie Atomique, Paris), D. Costes, C. Henri, C. Segot, and G. Lamiral. p.151-70 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 2." Vienna, International Atomic Energy Agency, 1962. (In French)

The safety of natural U graphite-moderated gas-cooled reactors depends on a large number of factors. The most important of these factors are considered and their importance in certain hypothetical accidents are evaluated. The intrinsic safety features of the reactor type in question are reviewed and precautions to be taken in choosing and applying various structural materials are indicated. Accidents following blocking of a channel and those caused by violent collapse are examined. The assumptions and methods of calculation used in determining aerodynamic and thermal behavior in various cases of accidents are discussed along with the effect of the most important parameters. Results are presented graphically. (auth)

1087 SAFETY PROBLEMS OF LIGHT WATER-MODERATED AND COOLED RESEARCH REACTORS. F. de Vathaire, J. Lacour, J. Rastoin, and E. de Robien (Centre d'Études Nucléaires, Saclay, France). p.171-80 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 2." Vienna, International Atomic Energy Agency, 1962. (In French)

The main problems involved in the operational safety of light water moderated and cooled research reactors are examined. More detailed consideration is given to the case of high power swimming pool reactors and that of materials testing reactors. Intrinsic and extrinsic safety factors, cooling and reactivity accidents, hazard factors connected with the presence of irradiation loops, and the required characteristics of the reactor building are also considered. Special studies which were carried out in France are briefly described. (auth)

1088 OPERATION OF A WATER-WATER POWER REACTOR IN THE EVENT OF A STOPPAGE OF THE CIRCULATING PUMPS. V. A. Sidorenko, Yu. V. Markov, and D. M. Potrunin (Kurchatov Inst. of Atomic Energy, USSR). p.181-203 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 2." Vienna, International Atomic Energy Agency, 1962. (In Russian)

A stoppage of the circulating pumps decreases the delivery of cooled water through the active zone of the reactor. If the pumps used in the reactor construction are of the

glandless kind with low inertia rotating parts, the delivery in the circuit decreases very rapidly when the electric motors driving the pumps stop. Sintered UO_2, the material most commonly used in the fuel elements of water-water reactors, is a very poor heat conductor. The working temperatures of the UO_2 are therefore fairly high, and the amount of heat accumulated in the fuel element material is correspondingly large. Consequently, a change in the thermal power of the active zone occurs rather slowly even in the event of a very rapid decrease in neutron flux density. A stoppage of the circulating pumps is therefore accompanied by an abrupt and considerable increase in the heat content of the heat carrier, possibly leading to boiling in the active zone, starting where the heat release is greatest. The boiling conditions in the various cooling channels worsens flow conditions in them for the heat carrier, leading to still greater steaming and to an abrupt deterioration in the conditions of heat removal. A study of the cooling of heat-producing elements in such conditions shows that if the electricity supply to the pumps is interrupted for prolonged intervals, it is impossible to prevent damage to the active zone. The possibility that this kind of damage may occur calls for improved reliability of the power supply to the circulating pump motors in water-water power reactors. (auth)

1089 SOURCE STRENGTH, DOSE RATE AND DOSAGE OF DIRECT RADIATION AT 100% CORE MELT-DOWN. F. L. Franzen (Technische Uberwachungs-Verein Essen, Ger.). p.285-96 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 2." Vienna, International Atomic Energy Agency, 1962. (In English)

In reviewing sites for planned power reactors, the consequences of the maximum credible accident to the public must be evaluated. Frequently, the maximum credible accident is identical with 100% core meltdown. Thereby fission products are released as gases and aerosols into the plant containment. Most of them remain inside of the containment as a source of direct radiation. A smaller portion leak out and subject persons in the neighborhood to inner and outer radiation. Data on fission product source strengths are presented. They enable estimation of radiation hazards to the public following a 100% core meltdown. The release rates of noble gases, halogens, and solids are shown. As an example, dose rates of the direct radiation depending upon the distance from a given reactor site are evaluated. (auth)

1090 THE MAXIMUM CREDIBLE ACCIDENT FOR A GAS-COOLED PEBBLE BED REACTOR (BBC-KRUPP REACTOR) WITH REGARD TO THE RELEASE OF RADIOACTIVITY. R. Kuester and O. Machnig (BBC-Krupp, Mannheim, Ger.). p.297-300 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 2." Vienna, International Atomic Energy Agency, 1962. (In English)

The BBC-Krupp-(AVR-) reactor has no built-in reactivity at normal operation. Residual heat being dissipated by natural convection, no considerable rise in temperature is to be expected in case of the maximum credible accident. Therefore, for the hazard to the surrounding population, only the fission product radioactivity of the cooling gas is important. This radioactivity, however, is very small, because of physical adsorption on the internal surface of the cold components in the cooling circuit, remaining cold even in case of accident. Results of measurements and theoretical considerations about the adsorption of fission products in graphite are reported. (auth)

1091 SAFETY OF THE OMR MARITIME REACTOR UNDER VERY HAZARDOUS CONDITIONS. H. Huebel and E. Schoenfeld (Internationale Atomreaktorbau-Gesellschaft, Cologne). p.301-6 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 2." Vienna, International Atomic Energy Agency, 1962.

The hazard analysis of the organic moderated and cooled maritime reactor includes the investigation of the loss-of-coolant-flow accident and the loss-of-pressure accident initiated by a primary system rupture. The investigation was performed to study the dynamic behavior of the system and to prove its safety in hazardous conditions. A mathematical description of the accidents allowed their simulation on an analog computer. Safety system setpoints were determined by the results obtained. In the case of loss-of-coolant-flow accident instances considered include loss of electrical power at both main coolant pumps, seizure of both main coolant pumps, and loss of electrical power at one main coolant pump. The dynamic behavior of the pumps was investigated. Primary system rupture and subsequent loss of coolant pressure may result in coolant boiling. Therefore the heat transfer properties of the two-phase-system was taken into account. (auth)

1092 THE DESIGN OF SAFETY SYSTEMS AGAINST FAST REACTIVITY PERTURBATIONS. P. Dosch (Kernreaktorbau-und Betriebsgesellschaft, Karlsruhe, Ger.). p.307-13 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 2." Vienna, International Atomic Energy Agency, 1962. (In English)

Most types of reactors are not inherently safe enough to take care of all perturbations, especially those from fast reactivity. For protection against these, safety systems are indispensable. Even a safety system cannot prevent the reactor being damaged in each case of reactivity perturbation. There is a critical velocity of reactivity perturbations, at which the critical temperature in the fuel is reached during shut-down. Faster reactivity perturbances cause damage of fuel elements. A complete mathematical presentation of the limit of capacity of a safety system is impossible. Several examples compiled with an analogue computer to show the general principles and basic requirements of a safety system are given. The remaining free parameters are suitably normalized and systematically varied in the analogue computations described. The results of these computations can be used for determining the necessary properties of safety systems if reactor data are given. On the other hand, they permit the determination of the maximum permissible reactivity rate for a given safety system, e.g. for start-up procedures or for permissible experiments in research reactors. The computation parameters comprise all important types of reactors. The technical requirements for design of safety systems are described. Their design even in extremely difficult cases, e.g. for fast reactors with a positive prompt temperature coefficient, seems possible as a general principle. (auth)

1093 MEASUREMENT OF THE TIME DELAY FOR THE FORMATION OF RADIOLYTIC BUBBLES AND ITS EFFECT ON THE DYNAMIC BEHAVIOUR OF THE FRF. K. Stelzer (Johann Wolfgang Goethe Universität, Frankfurt am Main). p.315-19 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 2." Vienna, International Atomic Energy Agency, 1962. (In English)

A delay in the formation of bubbles from radiolytic gas was found in the water boiler reactor FRF (Forschungsreaktor Frankfurt, built as Type L-54-F by Atomics International). If the reactor is brought to power after a pause in operation of several hours, measurements of the pressure in the primary system, with the recombination system shut off, show that equilibrium between production and evolution of gas from the fuel solution is reached only after an energy input of about 2.5 Mw/sec. The corresponding delay

times are 50 sec and 40 min for power steps of 50 kw and 1 kw respectively. The amount of gas stored in the fuel solution, in a form not contributing to the reactivity is nearly constant for core temperatures of 18 to 30°C and powers from 200 w to 10 kw. It amounts to about 6 l (NPT), compared with a core solution volume of 26.6 l and a corresponding gas solubility of about 0.7% at SPT. After shut-down, the gas evolves from the fuel solution with a time constant of about 40 min. Experiments performed with the FRF, with reactivity inputs up to $0.4, show that in this range the influence of bubbles is negligible as compared with the temperature effect. This can be attributed to the delay in the formation of bubbles. (auth)

1094 SAFETY PROBLEMS OF A PRESSURE-TUBE REACTOR. A. Meunier (Centre d'Etudes Nucléaires, Saclay, France). p.321-36 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 2." Vienna, International Atomic Energy Agency, 1962. (In French)

Safety problems concerned with heavy-water-moderated reactors cooled by pressurized CO_2 are examined. Particular attention is focused on the effects of pressure tube rupture on the heavy water vessel. (J.R.D.)

1095 THE ESTIMATION OF AVERAGE GAMMA DOSE RATES FROM SHIELD COOLING AIR IN THE NEAR VICINITY OF NUCLEAR POWER STATIONS. R. Scriven and D. Moore (Central Electricity Generating Board, London). p.339-75 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 2." Vienna, International Atomic Energy Agency, 1962. (In English)

A method is given for estimating the long-term average gamma dose-rates received at ground level within the site boundaries of a nuclear power station from Ar^{41} in the shield cooling air discharge. The method makes allowance for the fact that with the short exhaust stacks which are in use, the effluent will at certain wind speeds become entrained within the wake of the reactor buildings and be brought to ground level within the station boundaries. The effluent distributions are given simplified forms for calculation purposes and their validity assessed by carrying out smoke tests at nuclear power station sites and scale model tests in wind and water tunnels. The transition from plume to entrainment conditions with increasing wind speed is discussed in terms of reactor geometry, efflux velocity, etc. Brief mention is also made of the calculation of short-term dose rates. (auth)

1096 THE USE OF STRUCTURAL MODELS AND THE SIMULATION OF POWER TRANSIENTS IN REACTOR SAFETY INVESTIGATION. D. E. J. Samuels, R. F. Turner, and C. R. Warren (United Kingdom Atomic Energy Authority, Foulness, Southend-on-Sea, Eng.). p.377-88 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 2." Vienna, International Atomic Energy Agency, 1962. (In English)

Small scale structural models were used in several countries to investigate the consequences of severe fault conditions in reactor systems, where damage may arise from power transients or by depressurization resulting from a structural failure. A variety of applications of model techniques is discussed. The principles of scaling are stated and the limitations imposed on model experiments by the scaling laws are noted. The use of explosives, pyrotechnic mixtures, and electrical discharges to simulate a nuclear power excursion is discussed. It is shown that models may be either structurally scaled in strength in order to reproduce prototype damage, or may be geometrically scaled. Overstrong models are instrumented to measure transient pressure loads, flow parameters, or external effects. In the electrical method of simulating power transients, the circuit parameters are chosen to produce a critically damped energy pulse of specific duration. The dissipation of energy is further controlled by the mass and thermal properties of the resistive element used to simulate the core. The pulse shape is derived from the output of voltage probes and search coils and is displayed on oscillographs. Power-time curves produced by the discharge of 5000 J with durations of 30, 120, and 900 μsec are presented. These may be considered to represent, with a scale factor of $\frac{1}{30}$th, a power transient of 135 Mwsec with exponential periods of 120 μsec, 500 μsec, and 3 msec. Improvements to this method are discussed and its application in a number of reactor safety investigations is proposed. (auth)

1097 REACTIVITY CONSIDERATIONS IN REACTOR SAFETY EXPERIMENTS. W. B. Woollen (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.389-99 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 2." Vienna, International Atomic Energy Agency, 1962. (In English)

Since 1948, four high power research reactors, Bepo, Dido, Pluto, and Lido, and seven low power or zero energy reactors, Gleep, Nero, Neptune, Zephyr, Zeus, Dimple, and Daphne were subjected to a detailed and formal safety clearance procedure. Some of the more interesting points which received detail scrutiny by the working parties are discussed, in particular those concerning Bepo, Dido, and Daphne. (auth)

1098 THE ASSESSMENT OF WARNING LEVELS APPLICABLE TO ATMOSPHERIC EFFLUENTS FROM NUCLEAR INSTALLATIONS. X. de Maere and R. Boulenger (Centre d'Etudes de l'Énergie Nucléaire, Mol, Belg.). p.413-35 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 2." Vienna, International Atomic Energy Agency, 1962. (In French)

There are two warning levels for the control of atmospheric effluents from the CEN reactors, one for so-called "routine" wastes and a second for accidental wastes. The first of these two levels is calculated on the basis of the polar diagram of concentrations for each radionuclide considered, and integrated over a period of thirteen weeks for each reactor. The method used to calculate dilution coefficients and the principles applied for determining permissible dose levels in cases of chronic exposure of persons residing in the neighborhood of the reactors is described. The second level is calculated on the basis of an inventory of fission products which would theoretically be released into the atmosphere in the course of the maximum credible accident. The method used to calculate the minimum absolute dilution coefficient and the assumptions made in determining maximum permissible doses for the neighboring population in the event of a nuclear accident is also described. (auth)

1099 ACCIDENT ANALYSIS AS THE BASIS OF TECHNICAL EXAMINATION FOR THE SAFETY OF NUCLEAR REACTOR POWER PLANTS. O. Kellermann (Technischer Uberwachungs-Verein, Aachen). p.483-92 of "Reactor Safety and Hazards Evaluation Techniques. Vol. 2." Vienna, International Atomic Energy Agency, 1962. (In English)

A discussion is presented in which the necessity of fixing limits for reactor safety evaluation is considered. Other discussion is included on establishment of a uniform procedure for arriving at a judgement based on nuclear accident analysis, inspection of facilities, and the staff of nuclear power plants by independent experts, and general regulations for nuclear facilities. (J.R.D.)

1100 IMPROVEMENTS IN NUCLEAR REACTORS. Georges Lemesle, Roland Roche, and Pierre Rouge (to Commissariat à l'Énergie Atomique). British Patent 906,827. Sept. 26, 1962.

A system is designed for stabilizing reactor structures consisting of moderator and reflector blocks assembled to form vertical stacks. The system comprises a framework carried by the support base and constituting a cage surrounding the core and with inwardly extending resilient means bearing against the reflector elements of the core. The resilient means comprises pairs of spring blocks fixed on belts around the framework. (D.L.C.)

1101 INHIBITING REACTION BETWEEN CARBON DIOXIDE AND GRAPHITE IN HETEROGENEOUS NUCLEAR REACTORS. (to Allmänna Svenska Elektriska Aktiebolaget). British Patent 906,896. Sept. 26, 1962.

A method is given for preventing the $CO_2 + C \rightarrow 2CO$ reaction in CO_2-cooled graphite-moderated reactors. The method comprises supplying H_2 to the CO_2 coolant before it passes through the reactor core and removing the excess H_2O vapor from the coolant leaving the core. The concentrations may be 0.05 to 10% for H_2 (preferably 1%) and 0.05 to 0.1% for H_2O vapor. A circuit may also be provided for adding O_2 to the coolant to react with excess CO. (D.L.C.)

Power Reactors

1102 (ACNP-62017) PATHFINDER ATOMIC POWER PLANT. THERMAL AND HYDRAULIC DESIGN OF THE PATHFINDER BOILING WATER INTEGRAL NUCLEAR SUPERHEATING REACTOR. (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Aug. 29, 1962. For Northern States Power Co., Minneapolis and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. 161p.

A thermal and hydraulic design investigation of the Pathfinder Reactor, including analytical and experimental determinations, as well as a complete set of performance calculations, was carried out. A detailed analysis of the reactor energy balance was conducted. Results of the analyses indicated that the reactor will perform within the limits of the material design criteria and operational requirements. Fuel element temperatures are not excessive under the worst combination of circumstances. Thermal stresses in the superheater were minimized by designing the annular element so that temperatures are kept as uniform as possible at every axial location. In all cases, sufficient heat dissipation capacity was found to exist to ensure an ample margin of safety. (M.C.G.)

1103 (AECL-1599) THE EIGHTH AECL SYMPOSIUM ON ATOMIC POWER, HELD AT CHALK RIVER, ONTARIO, SEPTEMBER 24, 1962. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Sept. 1962. 85p.

Proceedings of the Eighth AECL Symposium on Atomic Power are presented. Separate abstracts were prepared for each of the eight papers. (M.C.G.)

1104 (AECL-1599(p.7-20)) LABORATORY TESTING OF NPD COMPONENTS. I. N. MacKay (Canadian General Electric Co., Ltd. Civilian Atomic Power Dept., Peterborough, Ont.).

Six groups of tests of NPD components and processes are described. They are tests of rolled joints, shaft seals, feeder-pipe welding, fueling machines, pressure relief duct, and fuel. (M.C.G.)

1105 (AECL-1599(p.21-31)) MANUFACTURE OF NPD COMPONENTS. C. L. Willcox (Canadian General Electric Co., Ltd., Peterborough, Ont.).

Problems in the manufacture of components for the NPD Reactor are discussed. The manufacture of fuel, pressure tubes, end fittings, fueling-machine magazine housing, reactor vessel (calandria), steam generator, pumps, heat exchange, valves, instrumentation and control, and shielding. (M.C.G.)

1106 (AECL-1599(p.32-9)) CONSTRUCTION OF NPD. R. J. Graham (Canadian General Electric Co., Ltd. Civilian Atomic Power Dept., Peterborough, Ont.).

Site construction for the NPD Reactor is described. The quantities of common construction materials employed are summarized. Scheduling of the work is discussed. Problems are described. (M.C.G.)

1107 (AECL-1599(p.40-2)) COMMISSIONING AND INITIAL OPERATION OF NPD. L. G. McConnell (Ontario. Hydro-electric Power Commission, Totonto).

The commissioning of the NPD reactor was classified into four phases: pre-critical, low-power reactor measurements, power run-up, and full-power shakedown. Each phase is described. The following problems are discussed: tube fittings, tube corrosion, moderator pump gaslocking, charging pump gaslocking, primary pump seals, and heavy-water losses. (M.C.G.)

1108 (AECL-1599(p.43-53)) UPRATED NPD OR 'HWR-80'. J. L. Olsen (Canadian General Electric Co., Ltd. Civilian Atomic Power Dept., Peterborough, Ont.).

Studies on the uprating of the NPD Reactor indicated that it would be possible to increase the power output by about 300% while increasing capital costs by about 25%. It was estimated that the most likely power output from this uprated heavy-water would be 80 Mw(e). The design changes that contribute most to the increase in power are described in a "before" and "after" approach. (M.C.G.)

1109 (AECL-1599(p.54-68)) STATUS REPORT ON THE DOUGLAS POINT PROJECT. D. L. S. Bate (Ontario. Hydro-electric Power Commission, Toronto and Atomic Energy of Canada Ltd. Nuclear Power Plant Div., Toronto).

Progress is reported on the Douglas Point 200000-kw nuclear power station. The design is reviewed. The status in the manufacture of the major items of equipment is described. On-site construction progress is outlined. The costs and completion schedule are discussed. (M.C.G.)

1110 (AECL-1599(p.69-82)) PROSPECTS FOR HEAVY-WATER REACTORS. J. S. Foster (Atomic Energy of Canada Ltd. Nuclear Power Plant Div., Toronto).

The use of heavy-water reactors for power generation is discussed. Prospects for application of heavy-water reactors in the next 10 years are outlined. World nuclear power prospects and contending reactor types are described. (M.C.G.)

1111 (AECL-1599(p.83-5)) POWER REACTOR DEVELOPMENT EVALUATION. W. B. Lewis (Atomic Energy of Canada Ltd., Chalk River, Ont.).

Assessments are being made to determine if the CANDU reactor design would survive economic competition and escape serious setbacks. Advantages of this design are discussed. (M.C.G.)

1112 (APED-3958) FINAL HAZARDS SUMMARY REPORT FOR THE ESADA VALLECITOS EXPERIMENTAL SUPERHEAT REACTOR. J. L. Murray, ed. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif. and Niagara Mohawk Power Corp., Buffalo). Oct. 1, 1962. 574p.

Includes Amendment No. 5: LICENSE APPLICATION FOR ESADA VALLECITOS EXPERIMENTAL SUPERHEAT REACTOR (EVESR). George White. 11p. (GEAP-3643)

Also available at Reading Room, AEC, Washington.

The ESADA Vallecitos Experimental Superheat Reactor (EVESR) is described in all of its significant safety aspects. The general features, reactor, nuclear characteristics, reactor heat transfer and fluid flow, reactor auxiliary systems, reactor emergency systems, power plant auxiliaries, control and instrumentation, waste disposal systems, miscellaneous plant systems, plant structures, and site and environment are described. Operational procedures and tests are listed. General safety features, reactivity addition accidents, loss of coolant accidents, fuel damage and system contamination, operator errors, equipment malfunctions, off-standard conditions, accidents during critical testing, accidents involving unplanned criticality, safety against fires and other general hazards, and radiological consequences of accidents requiring containment are discussed. (M.C.G.)

1113 (DLCS-5000862) MONTHLY OPERATING REPORT, AUGUST 1962. (Duquesne Light Co., Shippingport, Penna.). Contract AT(11-1)-292. 41p.

The station operated at power throughout the month. Chemical conditions of the water in the station cooling systems were satisfactory during the period. Tests concerning plant container integrity, reactivity lifetime, primary coolant crud, and chemical decontamination were initiated during the month. Other effort was devoted to preparation of procedures, reports and evaluations. Data and information concerning operations, refueling, maintenance, training, and plant modifications are included. (J.R.D.)

1114 (DLCS-5000962) DUQUESNE LIGHT COMPANY MONTHLY OPERATING REPORT, SEPTEMBER 1962. (Duquesne Light Co., Shippingport, Penna.). Contract AT(11-1)-292. 45p.

The significant operations, occurrences, and other station activities are summarized for the Shippingport Pressurized Water Reactor. Topics covered include: operations, station performance, incidents, chemistry, health physics, refueling, maintenance, test program, training program, and construction and major modifications. (M.C.G.)

1115 (EURAEC-48) CAN-1—QUARTERLY PROGRESS REPORT FOR THE PERIOD JULY 16, 1960 TO OCTOBER 15, 1960. Part A. Technical Report. Quarterly Report No. 3. (Ansaldo S. p. A., Genoa). Nov. 15, 1960. Work Performed under United States—Euratom Joint Research and Development Program. Contract 003-60-1RDI. 39p.

Preliminary air–water mixing experiments were performed with the low-pressure loop. A number of mixing nozzles were tested in order to determine the type of mixer which achieves a steady flow condition in the tube as soon as possible. It was assumed that these conditions are obtained when the axial quality of the mixture remains practically constant. Water pressure drop was found to affect strongly the stability of the axial quality whatever the test pressure. A general sketch and description of the high-pressure loop are also presented. (M.C.G.)

1116 (GA-2963) TESTS ON HALF-SCALE FLOW MODEL OF 40-MW(E) PROTOTYPE HTGR (PEACH BOTTOM ATOMIC POWER STATION). S. Ross, E. A. Dav, and R. A. Skeehan (General Atomic Div., General Dynamics Corp., San Diego, Calif.). June 20, 1962. Contract AT(04-3)-314. 118p.

A half-scale clear plastic nonnuclear flow model of the 40-Mw(e) Peach Bottom High-temperature Gas-cooled Reactor (HTGR) vessel and internals was operated during the period from January 1961, through October 1961. The model was operated as an induced system using ambient air as the working fluid. The maximum Reynolds number achieved in the model was approximately one-half of the Reynolds number corresponding to the full-load design conditions in the prototype. The prototype reactor pressure-drop values extrapolated from the flow-model data indicated a pressure drop of 2.0 psi for a helium flow rate of 468,000 lb/hr and pressure of 350 psia, and a constant inlet and outlet temperature of 650°F. The corresponding conservatively calculated pressure-drop value was approximately 2.9 psi. No areas of serious flow starvation were observed within the model during tests with flow through only one nozzle or through both nozzles. The inlet flow divided almost equally into the upward and downward directions. Regions where low velocities were indicated appeared to be turbulent and free from stagnation. Completely closing the four off-center openings in the top head reduced the flow of air from the outer flow jacket to the inner flow jackets by only about 20%. This result supported the design approach of providing only one nozzle in the center of the top head for flow from the outer to the inner flow jackets. The heat-transfer coefficients measured at the inner surface of the pressure vessel varied over a range from 50 to 200 Btu/(hr)(ft^2)(°F), at the design flow rate, and in general were about twice the calculated values for corresponding points. The tilting reflector was found to be a workable concept. No vibration or movement could be induced in the core by manual manipulation of various reflector blocks. There was no detectable vibration of the core during any mode of flow-model operation. (auth)

1117 (GAMD-1542) THERMAL DESIGN OF THE MGCR CORE. J. T. Rogers and R. Katz (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Aug. 4, 1960. Contract AT(04-3)-187. 88p. (MGCR-RE-277)

The design information is presented in sections on core thermal performance, fuel elements, moderator, and control rods. (J.R.D.)

1118 (GAMD-1652) THERMAL DESIGN OF THE MGCR CORE BARREL STRUCTURE. J. T. Rogers and R. Katz (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Oct. 11, 1960. Contract AT(04-3)-187. 53p. (MGCR-RE-277)

The core barrel was deemed to be the most critical member of the core support structure from the standpoint of thermal conditions. A report is presented on development of that portion of the core barrel immediately adjacent to the core; investigations concerning the nominal steady-state design conditions, coolant flow distribution, the effect of a gross coolant flow mal-distribution on the circumferential temperature and thermal stress distribution, and the effect of local uncooled areas on the local temperatures and thermal stresses are described. It was found that one in. of metallic insulation is required to protect the core barrel which is cooled by one-half of the total coolant flow at the inlet temperature conditions passing through a $1\frac{5}{8}$ in. annular gap. This resulted in the maximum design temperatures for the core barrel of 815 and 944°F at core outlet temperatures of 1300 and 1500°F, respectively. Some form of internal header will be necessary to provide a reasonably uniform flow distribution around the core barrel although a flow distribution with a ±25% maximum velocity variation could probably be tolerated from a thermal stress standpoint. Experimental work will be necessary to determine the actual flow distribution and pressure losses. Analysis showed that local thermal stresses in areas which are poorly cooled be-

cause of obstructions, non-symmetric flows, or other causes will probably not be excessive, therefore, great care and complexity to ensure perfectly uniform local cooling is not necessary. (auth)

1119 (GEAP-3372) VALLECITOS BOILING WATER REACTOR DECONTAMINATION PROGRAM. D. W. Danielson and M. L. Brewer (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Mar. 15, 1960. 32p.

A test program was carried out to determine the corrosion effects and decontamination efficiency of selected decontamination solutions for use in the VBWR system. Decontamination plans for the system were prepared but cancelled in favor of local decontamination with a power wire brush. The VBWR contamination levels were not as high nor as troublesome as anticipated so the use of any of the currently recognized system decontamination treatments, effective or not, could not be justified in terms of over-all cost saving. Decontamination treatments in vogue at other sites were ineffective on coupons removed from the VBWR cleanup system but were effective on pressurized water loop coupons. An effective decontamination method found for the VBWR coupons involved the use of sodium acid sulfate with added mixed fluorides but beaker tests also showed the treatment can cause stress cracking of sensitized 304 stainless steel. The VBWR coupons are decontaminated most effectively by a different type of treatment than the pressurized water loop coupons suggesting that a different type of scale occurs in a boiling water reactor. For any future decontamination operation, the importance of a test program utilizing coupons truly representative of the actual system to be decontaminated is underscored. The over-all program recommended includes development of a chemical treatment suitable for system decontamination but stresses a thorough study of local decontamination and of non-chemical decontamination methods. (auth)

1120 (HW-72263(Rev.)) THE PLUTONIUM RECYCLE TEST REACTOR SHIELDING EVALUATION. L. D. Williams (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 9, 1962. Contract AT(45-1)-1350. 20p.

The x-ray film studies of the top and bottom primary shields displayed definite gamma radiation streaming from around the shim control shroud tubes, monitor tubes, and other access holes, but showed effective shielding above and below the process tubes and primary shields. The biological shielding displayed no leaks or weak spots except for areas around all the flux monitor channels and an access hole near the ceiling in −32′ C Cell. The bulk of the data indicated a linear increase in dose rate as a function of reactor power level. General gamma dose rates throughout A Cell were 1 to 3 r/hr at 70 Mw, while the general background in B and C Cells varied from 0.7 to 6 mr/hr. Fast neutron dose rates in A Cell reached 220 mrem/hr at 10 Mw. B and C Cell neutron dose rates with the reactor at 70 Mw were less than 1 mrem/hr. The average ratio of fast neutron dose rate to gamma dose rate through the rotating shields remained constant at 4 : 1 as the fast neutron dose rate increased from background at 1 Mw to 30 mrem/hr at 70 Mw. Tabular and graphic data summarizing the results are presented. Illustrations showing the penetrations in the biological shielding are included. The film holders used during the filming of the top primary shield are illustrated. (auth)

1121 (LA-2707) FAST REACTOR ENGINES—CRITICALITY. Ralph S. Cooper (Los Alamos Scientific Lab., N. Mex.). May 1962. Contract W-7405-eng-36. 70p.

Critical sizes are determined for a variety of fast assemblies appropriate for nuclear rocket reactors. These are based on cores of UO_2-W cermets or UC-metal carbide solid solutions reflected by Be. Rocket reactors weighing as little as 200 lb are possible, and, in larger sizes, either high power density or high exit gas temperature can be achieved. The fast spectrum allows the use of the most refractory materials (such as HfC) in bulk to obtain high performance. Use of U^{233} in place of U^{235} can lead to substantial improvements in reactor weight, specific power, and/or temperature capability at the cost of the radiation associated with U^{233}. The core sizes are generally quite small, which is valuable where shielding may be significant. Nuclear aspects, including control, U investment, power distribution, and reflector materials, are briefly discussed. (auth)

1122 (LAMS-2259) SOME REACTOR PHYSICS IN THE ROVER PROJECT. C. B. Mills (Los Alamos Scientific Lab., N. Mex.). Sept. 1958. Contract W-7405-eng-36. 39p.

A general and systematic development of reactor computing methods and detailed application given in report LAMS-2255 is supplemented for a few specific systems of the Rover program. Neutron cross sections, reactor description, and computed results are given for a reactor required to have a constant (radially) power distribution at high temperature. (auth)

1123 (NAA-SR-5675) DEVELOPMENT OF PROTOTYPE PROCESS SYSTEMS FOR OMR. W. N. Bley, J. A. Vanderlip, and R. R. Stiens (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1962. Contract AT-11-1-GEN-8. 34p.

Three pilot plant process systems were operated to provide engineering data for the design of Advanced Organic Moderated Reactor (AOMR) processing systems. The performance of purification, degasification, and waste gas and water treatment systems was studied and compared with expected performance. The systems were previously constructed and evaluated as part of the Piqua OMR process development program. Operation of the purification system was carried out to evaluate column performance and compare predicted and experimental results. Operation of the degasification system was limited to the problems associated with development of a satisfactory procedure for determining the water content in Santowax OMP. In addition, development of special steam-tracing for differential pressure cells and rotameters was required to insure reliable performance. System control and reliability were demonstrated in the operation of the purification and degasification systems. The waste gas and water treatment system was employed to remove radioactive and organic contaminants from the gaseous and aqueous effluent streams of the purification and degasification systems. Contaminants in the gas stream were removed by water scrubbing followed by filtration. Aqueous activity was maintained below the maximum permissible concentration by means of filtration through a diatomaceous earth filter. (auth)

1124 (NAA-SR-7036) PROCESS DEVELOPMENT AND FABRICATION OF PbTe THERMOELECTRIC ELEMENTS. F. R. Bennett and K. Langrod (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 30, 1962. Contract AT(11-1)-Gen-8. 24p.

The development and fabrication of Pb-Te pellets, contacted to Fe end caps, for use as elements in thermoelec-

tric converters for the SNAP 10A program, is described. The method adopted consists of contacting, by hot pressing in a controlled atmosphere, 24 pellets simultaneously, using 4-layer, 6-cavity graphite dies. The optimum hot pressing parameters were found to be 5000 psi at 1550°F for 30 min. Several thousand elements were produced by this relatively high-volume process, modifying the normally slow and expensive hot pressing by the use of multilayer, multicavity dies and automatic controls. (auth)

1125 (NAA-SR-Memo-7526) HNPF DRY AND WET CRITICAL CALCULATIONAL METHODS. M. P. Aronchick (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 29, 1962. Contract [AT-11-1-GEN-8]. 22p.

The methods used in Hallam Nuclear Power Facility (HNPF) dry and wet critical calculations are described. The methods were used in studying the various safety aspects of pre-operational and operational procedures on dry critical and dry excess loadings in order to obtain information on the nuclear performance of the HNPF core. The core reactivity calculations were performed within the ultimate framework of one-dimensional few-group diffusion theory in cylindrical geometry, digital computer codes being the principal tools for the reactor calculations. (N.W.R.)

1126 (NASA-TN-D-1529) COLD-AIR INVESTIGATION OF PROTOTYPE SNAP-8 TURBINE. William J. Nusbaum and Donald E. Holeski (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Oct. 1962. 16p.

The important geometric features of a prototype SNAP-8 turbine and the results of a cold-air performance evaluation in a range of blade-to-jet-speed ratios from 0.13 to the design value of 0.3 are presented. (auth)

1127 (NP-12157) COMMISSIONING AND INITIAL OPERATION OF CANADA'S FIRST NUCLEAR-ELECTRIC GENERATING STATION — NUCLEAR POWER DEMONSTRATION. L. G. McConnell (Ontario. Hydro-electric Power Commission, Toronto). [Aug. 31, 1962]. 61p.

Information concerning commissioning of the station is presented along with comments regarding early operation. A detailed description of all the problems encountered was considered impractical; however, an ad hoc selection of problems is described which is thought to be representative. A brief design description is included. (J.R.D.)

1128 (TID-16730) COMPUTER PROGRAMS FOR OPTIMUM START-UP OF NUCLEAR PROPULSION SYSTEMS. C. N. Shen (Rensselaer Polytechnic Inst., Troy, N. Y.) and F. G. Haag (Knolls Atomic Power Lab., Schenectady, N. Y.). [July 16, 1962]. Contract [W-31-109-eng-52]. 4p.

Kinetic equations are derived for use in computer programs for optimum startup of nuclear propulsion systems The propulsion systems are of the types used in nuclear-powered rockets in which the power traverses the last three decades in less than a minute. (N.W.R.)

1129 (WAPD-PWR-TE-144) FAST NEUTRON FLUX MEASUREMENT OUTSIDE THE PWR PRESSURE VESSEL. SHIPPINGPORT PWR-1 SEED 3. DLCS-40201; DLCS-40202. Test Evaluation. K. P. Barr, J. H. Leonard, and G. G. Smith (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Aug. 9, 1962. Contract AT (11-1)-Gen-14. 20p.

Results and evaluations concerning fast neutron flux measurements made outside the pressure vessel in a source-range instrument well during PWR-1 seed 3 life are presented. These measurements were made to obtain data from which to calculate the fast neutron exposure inside the PWR vessel. It is concluded that the fast flux on the inside of the pressure vessel wall calculated by the P1MG shielding method is adequate for determining pressure vessel irradiation characteristics. (J.R.D.)

1130 (WAPD-TM-321) FABRICATION DEFECTS OBSERVED IN PWR CORE 1 BLANKET FUEL RODS. L. R. Lynam, E. F. Losco, G. J. Salvaggio, and J. G. Goodwin (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Sept. 1962. Contract AT(11-1)-Gen-14. 53p.

A PWR Core 1 blanket fuel rod which operated for approximately 13,700 EFPH with a complete cladding penetration was removed from the Shippingport reactor and examined, after replacement of Seed 2, along with adjacent nondefective irradiated and nonirradiated rods. No unusual or unanticipated conditions were noted as a result of reactor operation with the cladding penetration. The defect was traced to a transverse tubing crack originating at the inside cladding surface during tube fabrication. Defects of the same type but varying in depth and number were noted in irradiated and nonirradiated rods fabricated from the same lot used in the PWR Core 1 blanket. Although these defects have little or no adverse effect on internal gas burst pressures, they do, however, reduce the average cladding ductility when the depth of the defects exceeds about 7 mils. A worst case reduction of 11% in cladding strain was noted on burst testing a rod which had a particularly large number of relatively deep defects. (auth)

1131 (YAEC-182(Pt.I)) YANKEE IRRADIATION PROGRAM. SUMMARY REPORT, PART I. YANKEE INPILE LOOP IRRADIATION TEST. D. C. Bullington (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Jan. 1962. For Yankee Atomic Electric Co., Boston. Contract AT(30-3)-222, Subcontract No. 1. 66p.

An in-pile loop test program is described for evaluation of stainless steel-clad UO_2 behavior in pressurized water at 600°F under irradiation. The corrosion behavior of Zircaloy-2, 304 stainless steel, and Ag-In-Cd control rod material was also tested in a similar environment. The hideout behavior of lithiated boric acid at Yankee operating conditions of temperature, heat transfer, and irradiation was also evaluated. (J.R.D.)

1132 (FTD-TT-62-1068) EXAMINATION OF HEAT TRANSFER PROCESSES IN HEAT-PRODUCING ELEMENTS OF NUCLEAR REACTORS BY METHOD OF HYDRAULIC MODELLING. O. I. Yaroshevich. Translated from Inzh.-Fiz. Zh., Akad. Nauk Belorussk. SSR, 3: No. 5, 81-5(1960). 9p.

Results of an investigation concerning unsteady temperatures in full elements of water-moderated and cooled reactors are presented. A hydraulic model is presented in which the heat conduction variations in the element are considered in relation to temperature, and to dimensional changes. The effects of the negative temperature coefficient of reactivity are also considered in the model. (J.R.D.)

1133 CONSTRUCTION AND ENGINEERING PROBLEMS OF DOUNREAY FAST REACTOR. Arnošt Hoenig (Brno Tech. Univ.). Jaderna Energie, 8: 194-202(1962). (In Czech.)

Fundamental engineering data of the Dounreay fast reactor are reported. The design and construction of the pressure sphere, some specific aspects of the design, and strength tests are described. (auth)

1134 PROBLEMS OF ADDITIONAL STRESSES OF POWER REACTOR CONSTRUCTION WITH LOW THERMAL INERTIA CAUSED BY THE INTERFERENCE OF SAFETY SYSTEM. Jan Hulovec. Jaderna Energie, 8: 268-73(1962). (In Czech.)

Problems of additional stresses in gas-cooled power reactors with low thermal inertia during its shut-down with safety rod are discussed. The equations of the dynamics of primary (gas-) cycle of a nuclear power station were derived. The possibility of rapid flow reduction of cooling medium through the reactor, and the influence of this reduction of flow on maximum values of additional stresses of reactor parts, namely of its exit hot part and of main gas tubes, were investigated. (auth)

1135 COMPUTER CONTROL OF POWER REACTORS. Junichi Mida, Masao Hara, Yasushi Hinata, Nobuhide Suda, and Yoshikuni Shinohara (Japan Atomic Energy Research Inst., [Tokyo]). Nippon Genshiryoku Gakkaishi, 4: 621-6 (Sept. 1962). (In Japanese)

A survey is presented on the computer control of power reactors. Three stages of development of the computer control are considered, namely data logging, supervising control, and direct control. Computer control is found to be predominantly in the stage of data logging. Plans are reported to apply the supervising and direct control to power reactors. (auth)

1136 DIRECTORY OF NUCLEAR REACTORS. VOL. IV. POWER REACTORS. (Revised and Supplemented Edition of Vol. I). (International Atomic Energy Agency, Vienna). 1962. 335p. (STI/PUB/53). $5.00 (IAEA)

The information is presented so that the first page of each entry contains general information, the second and third pages provide sketches of fuel assemblies and reactor sections, the fourth page presents heat transfer, control, and dimensional data, the fifth page contains a flow diagram, and the sixth page presents data on reflector, shielding, containment, generators, and cost. The reactors are grouped according to type. An alphabetical index is included. (J.R.D.)

1137 A CURRENT ASSESSMENT OF THE ORGANIC-COOLED HEAVY-WATER MODERATED REACTOR. W. M. Campbell (Atomic Energy of Canada Ltd., Chalk River, Ont.). Preprint. [Ottawa], Canadian Nuclear Association, 1962. 14p.

The organic-cooled, heavy-water-moderated reactor (OCDR) has been under development in Canada for three years. Basic design is similar to the CANDU reactor. To date, the terphenyls seem most promising as coolant. Problems still being investigated involve fouling of heat transfer surfaces, core materials, coolant-tube design, and fuels. It is concluded that if organics are to find a place as a power reactor coolant they must be used at conditions beyond existing practice or knowledge, but research and development work seems promising. (A.G.W.)

1138 DEVELOPMENT OF SOLID-INSULATED PRESSURE TUBES FOR CANDU-TYPE REACTORS. K. L. Smith (Atomic Energy of Canada Ltd., Chalk River, Ont.). and D. Caple. Preprint. [Ottawa], Canadian Nuclear Association, 1962. 24p.

The solid-insulated cold pressure tube design is being developed as an alternative to the hot pressure tube for future CANDU-type reactors. The results of the solid-insulation development program are described. Laboratory tests were performed on various insulations, and granular silica was chosen for further work. Procedures for inserting this insulant into pressure-tube assemblies were successfully developed. Pressure-tube model tests indicated that the liner and insulation were stable under extended thermal cycling. Tests performed with the inner liner punctured or cut provided data on the effects of liner failure and established the feasibility of the liner-failure detection system. (auth)

1139 REFUELLING AND FUEL HANDLING FOR CANDU REACTOR. F. S. Hummel, B. C. Stonehill (Dilworth, Secord, Meagher and Associates Ltd.), and C. E. Beynon. Preprint. [Ottawa], Canadian Nuclear Association, 1962. 44p.

The CANDU reactor being built on the shore of Lake Huron is one of the first full scale power reactors to use "on power" refueling. It is of the horizontal coolant tube type. These contain fuel bundles through which coolant circulates at 1500 psi and 560°F. The advantages of "on power" refueling are covered, along with the problem areas and their solutions. To refuel a channel, two identical fueling machines are attached, one at each end of the channel. One serves as a new fuel charge machine and the other as a used fuel discharge machine. The machines clamp and make a seal to the end of the coolant tube end fitting, remove the closure plugs and the shielding plugs, and work in unison to move the string of fuel bundles back and forth in the channel under control of rams which are part of the fueling machines. In this way a new bundle is added to the end of the string and a used fuel bundle removed from the other end to be handled by the fuel transfer system and transported to a storage bay by a shuttle in a hydraulic tube. The fuel machine carriage runs horizontally on tracks on the floor and the head moves vertically, guided by columns attached to the carriage. The required lattice position is selected, and the head homes and connects to the end fitting automatically to an accuracy of ±0.085 from the true position. Any misalignment is accommodated by the gimbal mounted head and flexibility in the end fitting. (auth)

1140 CIVIL ENGINEERING FEATURES OF A NUCLEAR POWER PLANT. N. S. C. Haines (The Hydro-Electric Power Commission of Ontario, Toronto). Preprint. [Ottawa], Canadian Nuclear Association, 1962. 16p.

Unusual requirements encountered in the design of structures for the Douglas Point nuclear power plant are reviewed. Considerations in selection and arrangement of the site and general criteria for design of buildings are discussed briefly. Design specifications and construction methods for the reactor building and reactor vault are described in more detail. (A.G.W.)

1141 HEAVY WATER POWER REACTORS: FUNDAMENTALS OF ECONOMIC DESIGN. W. B. Lewis (Atomic Energy of Canada Ltd., Chalk River, Ont.). Preprint. [Ottawa], Canadian Nuclear Association, 1962. 12p.

Estimates of capital charges, fuel costs, and operating costs for a coal-fired and a nuclear plant now under construction in the Ontario Hydro Electric System are tabulated. These costs are compared with estimates of what future costs must be in order to keep the unit cost of power competitive. Conditions to be satisfied in the following four areas in nuclear power plant design are listed: (1) the fission chain reaction and neutron economy; (2) heat transport and thermal efficiency; (3) reactor control; (4) fuel supply and removal. Fundamentals involved in satisfying these conditions are discussed. Major reductions in cost are expected to come from cheaper heavy water, less heavy water, increased thermal efficiency, and simplified construction. (A.G.W.)

1142 HALLAM NUCLEAR POWER FACILITY STARTUP PROGRAM. J. E. Owens (Atomics International, Hallam, Neb.). ASME Preprint No. 62-PWR-5. New York, American Society of Mechanical Engineers, 1962. 16p.

A description of the plant, its construction, training program, test procedures, and requirements for final acceptance is presented. (auth)

1143 TRAINING OF OPERATING PERSONNEL AT SHIPPINGPORT. C. N. Dunn (Duquesne Light Co., Pittsburgh). AIEE Preprint No. CP 62-1334. New York, American Inst. of Electrical Engineers, 1962. (Prepublication Copy). 26p. $1.00.

There is a definite need for a formalized training program at any nuclear power station. The program should include provisions to train new personnel as well as provisions for a periodic refresher training to maintain the necessary degree of proficiency in those already qualified as operators or operating supervisors. A summary is given of the training program used by Duquesne Light Company at its Shippingport Atomic Power Station. (auth)

1144 COMPUTER CONTROL CONCEPTS FOR A MOBILE NUCLEAR POWER PLANT. Harvey DeCovnick (Aerojet-General Nucleonics, San Ramon, Calif.). ISA Preprint No. 4.5.62. Pittsburgh, Instrument of Society of America, 1962. 6p.

Considerations of weight, environmental conditions, and military applications, as well as the quality of power produced, are essential factors in control concepts for a mobile nuclear power plant. Advantages offered by computer controls in weight and volume, mobility, improved plant efficiency, self-checking and fail-safe features, and ease of operation and maintenance are discussed. Use of a computer to replace present process control instrumentation is described, and its advantages and disadvantages are evaluated. (auth)

1145 BOILING WATER REACTOR CONTROL SYSTEMS. E. R. Owen (General Electric Co., [San Jose, Calif.]). AIEE Preprint No. CPA-62-5108. [New York, American Inst. of Electrical Engineers, 1962]. (Prepublication Copy). 27p.

The basic characteristics of a boiling water reactor (BWR) that relate to and affect reactor dynamic behavior are described. The response of the BWR power level to changes in reactor parameters is discussed. Basic methods of reactor control are then reviewed with practical utility applications in mind, and the characteristics of certain control configurations are developed. Specific control systems are proposed and their related operating characteristics are reviewed. Electric utility plant load-following requirements are examined. It is concluded that the BWR can be controlled in such a manner as to readily meet most utility company load-following requirements. (auth)

1146 MEANS FOR THE GENERATION OF SUPERHEATED STEAM IN NUCLEAR REACTORS. (to Brown, Boveri and Cie). British Patent 906,556. Sept. 26, 1962.

A boiling reactor is designed for superheating steam. The reactor comprises two zones, one at a relatively low temperature and the other at a higher temperature, and both zones are mounted in a common reactor vessel. Water is evaporated in the first zone and the steam superheated in the second zone. (D.L.C.)

1147 THERMAL REACTORS. Roy Jackson Smith (to General Electric Co. Ltd.). U. S. Patent 3,055,820. Sept. 25, 1962.

A reactor control system is designed which is particularly suitable for adjusting the power output of a power reactor. The system maintains a constant ratio of neutron flux to coolant flow and thus keeps the temperatures within the core substantially constant. In this system, two separate closed-loop automatic control circuits are provided for stabilizing the neutron flux and coolant flow, respectively. The two circuits are coupled through a ganging shift to form a single control means operated from a lever key. (D.L.C.)

Production Reactors

1148 (HW-69488) STEAM-WATER CRITICAL FLOW TEST DESIGN TEST 1040. J. Muraoka (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 1, 1961. Contract AT(45-1)-1350. 40p.

Explicit critical flow experiments were performed at critical pressures up to 750 psia. Steam qualities and mass velocities achieved ranged up to 30% and 8100 lb/sec-ft^2, respectively. When plotted on the empirical correction curve suggested by Isbin, the test data were consistently below the low-pressure curve determined by Isbin et al. Thus, it appears that the maximum critical flow rate is obtained for a given set of inlet conditions by applying Isbin's correction curve. Since the purpose of this test was to gather critical flow information quickly to confirm certain portions of the NPR design, the emphasis was placed on speed. The data obtained were consistent with existing critical flow correlations based on void fraction data. (auth)

Research Reactors

1149 (IDO-24040) ADVANCED TEST REACTOR—ATR PRELIMINARY SAFETY ANALYSIS REPORT. (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va. and Ebasco Services, Inc., New York). Apr. 1962. Contract AT(10-1)-1075. 615p.

A description, with safety and accident analyses, of the Advanced Test Reactor is presented. Topics covered include: site; reactor building; reactor structure, shielding, and experiments; reactor core; primary coolant system; instrumentation and control; control element drives; electrical systems; secondary coolant systems; auxiliary systems and machinery; critical facility; accident analysis; coupling between reactors in MTR-ETR-ATR area; hazards analysis; emergency evaluation procedures; and research and development programs. (M.C.G.)

1150 (JAERI-1024) TREATMENT AND ANALYSIS OF THE WATER AND GAS IN JRR-2. (Japan Atomic Energy Research Inst., Tokyo). Apr. 1962. 86p. (In Japanese)

The methods and equipment adopted for drying and inserting heavy water and helium into the JRR-2 are described along with the problems involved in analyzing heavy water, conversion of the ion-exchange resin from light to heavy water, purification of helium, and treatment of the secondary cooling water. (N.W.R.)

1151 (JAERI-1027) THE FIRST LOADING FUEL ELEMENTS AND POWER-UP FOR JRR-2. (Japan Atomic Energy Research Inst., Tokyo). Jan. 1962. 64p. (In Japanese)

The first startup test of JRR-2, made in March 1961, is described. The specifications, testing procedures, and results are discussed along with the problems involved, safety aspects, and fuel elements used. The operational procedures and mechanism of the detectors for measuring fuel cladding rupture are described. (auth)

1152 (ORNL-TM-379) TEMPERATURE AND REACTIVITY COEFFICIENT AVERAGING IN THE MSRE. B. E. Prince and J. R. Engel (Oak Ridge National Lab., Tenn.). Oct. 15, 1962. Contract [W-7405-eng-26]. 23p.

Use is made of the concept of "nuclear average temperature" to relate the spatial temperature profiles in fuel and graphite attained during high power operation of the MSRE to the neutron multiplication constant. Based on two-group perturbation theory, temperature weighting functions for fuel and graphite are derived, from which the nuclear average temperatures may be calculated. Similarly, importance-averaged temperature coefficients of reactivity are defined. The values of the coefficients calculated for the MSRE were -4.4×10^{-5}/°F for the fuel and -7.3×10^{-5} for the graphite. These values refer to a reactor fueled with salt which does not contain Th. They were about 5% larger than the values obtained from a one-region, homogeneous reactor model, thus reflecting the variation in the fuel volume fraction throughout the reactor and the effect of the control rod thimbles on the flux profiles. (auth)

1153 (ZFK-RN-14) BESTIMMUNG DER GAMMA-STRAHLUNG DES ROSSENDORFER FORSCHUNGS-REAKTORS NACH DEM ABSCHALTEN. (Determination of the Gamma Radiation of the Rossendorf Research Reactor after Shutdown). Wolfgang Suckow (Germany. Zentralinstitut für Kernphysik, Dresden). Aug. 1961. 20p.

The gamma radiation of the Rossendorf Research Reactor after shutdown was measured with ionization chambers as a function of location and time. The experimental values were used to draw diagrams for the determination of the irradiation dose. Furthermore, the curves were described by interpolation formulas, and their behavior was discussed. The accuracy of the measured values was investigated, and their applicability for the computation of irradiation doses was estimated. (auth)

1154 EXPERIMENTAL REACTOR LOOPS IN THE INSTITUTE OF NUCLEAR RESEARCH IN REZ NEAR PRAGUE. František Berger and Emil Pelčik (Inst. of Nuclear Physics, Czechoslovak Academy of Sciences, Rez). Jaderna Energie, 8: 263-7(1962). (In Czech.)

An evaluation of the importance of experimental loops and a short description of loop components are given. The gas-cooled loop built in the WWR-S reactor in Rez is described in detail. The following experimental equipment are mentioned: an inactive rig with circulating gas, a pressurized water loop for the investigation of the influence of radiation on metal corrosion, the design of a sodium loop with natural circulation of the coolant, and the design of an organic cooled loop. (auth)

1155 THE DEVICE FOR AUTOMATIC CONTROL OF NUCLEAR REACTOR IN REZ, CZECHOSLOVAKIA. Pavel Kovanic, Jaroslav Rygl, Antonin Malanik, Karel Wagner, and Josef Teska. Jaderna Energie, 8: 285-6(1962). (In Czech.)

The described device controls its own ability for starting the reactor, the start of the reactor from subcritical to given power and power changes to a given value. The device also controls whether the reactor state corresponds to the required state. In case of failure of the regulator the device automatically transfers the power or period regulating function to another system. Corrections of control rod position are also made automatically. Three fission chambers are used as movable detectors for the whole range of reactor power changes. The minimum power regulated automatically is 10 w, and this value is also the lower limit of application for positive and negative periods. The upper limit of the device is given by the nominal power of the reactor 2000 kw. The control device itself might be used without adaptation up to 100 Mw. The device enables measurement of periods up to 2.5 sec and automatic control of period up to 3.5 sec. During normal operation a working period of 20 sec is used. Automatic startup takes 10 to 15 min including automatic self control. A complete documentation of the new device, descriptions, figures, schemes, operation rules, and the results of tests are included. (auth)

SPACE APPLICATIONS AND TECHNOLOGY

1156 (NASA-TN-D-1323) NUMERICAL SOLUTION OF TWO-DIMENSIONAL POISSON EQUATION: THEORY AND APPLICATION TO ELECTROSTATIC-ION-ENGINE ANALYSIS. Vladimir Hamza and Edward A. Richley (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Oct. 1962. 80p.

The Poisson equation is solved for mixed boundary conditions by a method of successive approximations in which the differential equation is replaced by finite difference equations. Properties of the resulting matrix are studied. The Cyclic Chebyshev Semi-Iterative Method is described, and detailed calculations of ion trajectories are given. Also included is a numerical example, solved on an IBM 704 computer, for an ion rocket engine. (auth)

1157 SIXTH SEMIANNUAL REPORT TO CONGRESS, JULY 1 THROUGH DECEMBER 31, 1961. (National Aeronautics and Space Administration, Washington, D. C.). 1962. 194p. $1.00(GPO).

A detailed review is presented of NASA accomplishments and progress. Some of the items covered are manned space flight, satellite applications, geophysics and astronomy programs, unmanned lunar and interplanetary programs, propulsion and power generation, space research, and life sciences. (D.L.C.)

1158 NUCLEAR ROCKET INSTRUMENTATION. Paul Erskine Brown (Radio Corp. of America, Camden, N. J.). ISA Preprint No. 52.3.62. Pittsburgh, Instrument Society of America, 1962. (Prepublication Copy). 11p.

In order to utilize fully the 10:1 advantage in thrust and payload of the nuclear rocket over the chemical rocket, the reactor should be operated at sustained high temperatures and neutron flux levels which exceed the operational and environmental capabilities of conventional neutron, temperature, and other sensors. A high-speed control computer is required especially for the transient conditions of startup, shutdown, and restart. Temperature and neutron flux sensors have been developed using carbon and silicon carbide which have excellent nuclear and thermal properties. Outstanding problems are flow measurements of two-phase cryogenic fluids and high accuracy temperature measurements below 40°K. (auth)

WASTE DISPOSAL AND PROCESSING

1159 (HW-SA-2744) LABORATORY, PILOT AND FIELD SCALE STUDIES OF FISSION PRODUCT MIGRATION RATES IN SOIL. J. L. Nelson, W. A. Haney, K. C. Knoll, and D. W. Bensen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 5, 1962. Contract AT(45-1)-1350. 23p.

Results of laboratory, pilot, and actual waste disposal studies relating to the migration rates of fission products in soils are presented. Work planned to obtain a more accurate definition of the radioisotope capacity of specific disposal sights is also described. The variables that influence the rate of movement of trace concentrations of radio-cations in soil were determined. Methods were investigated for extrapolating laboratory results to field disposals, and model waste disposal facilities were constructed. (M.C.G.)

1160 (IDO-14586) DEVELOPMENT OF A FLUIDIZED BED CALCINATION PROCESS FOR ALUMINUM NITRATE WASTES IN A TWO-FOOT-SQUARE PILOT PLANT CALCINER. PART I. EQUIPMENT DEVELOPMENT AND INITIAL PROCESS STUDIES. B. P. Brown, E. S. Grimmett, and J. A. Buckham (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). June 20, 1962. Contract AT(10-1)-205. 121p.

A two-foot-square fluidized bed calciner was designed and operated to convert aqueous, highly radioactive wastes into granular solids. The calciner exceeded its designed feed capacity of calcining, at a bed temperature of 400°C, 100 liters per hour of aluminum nitrate solution simulating wastes from the reprocessing of spent aluminum-uranium alloy reactor fuel. Heat was supplied to the calciner by circulating NaK with an electromagnetic pump, at temperatures up to 1400°F, through a tubular heat exchanger placed directly in the fluidized bed of solids. The results of ten runs are presented and discussed. Equipment development progressed to the point where a continuous, trouble-free, operating period of 43 days was attained. Several properties of the alumina product were routinely measured, and some of the effects of the calciner operating variables on these properties were determined. The production of both amorphous and alpha crystalline material was found to be possible; the crystalline nature of the product had a profound effect on product properties and off-gas loading. (auth)

1161 (IDO-14587) DEVELOPMENT OF A FLUIDIZED BED CALCINATION PROCESS FOR ALUMINUM NITRATE WASTES IN A TWO-FOOT-SQUARE PLANT CALCINER. PART II. FACTORS AFFECTING THE INTRA-PARTICLE POROSITY OF ALUMINA. B. R. Wheeler, E. S. Grimmett, and J. A. Buckham (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). July 25, 1962. Contract AT(10-1)-205. 28p.

A seven- to twenty-fold volume reduction can be obtained from fluidized bed calcination of aqueous aluminum nitrate wastes, depending on the operating conditions employed and their effect on the intra-particle porosity and absolute density of the calcined alumina. Among the calcining variables, only the bed temperature and the fuel aluminum concentration had a significant effect on the intra-particle porosity of alumina generated during studies conducted primarily in a two-foot-square fluidized bed calciner. A quantitative correlation of the effect of these variables is presented. Alumina with an intra-particle porosity as low as five per cent can be generated by employing a suitable combination of low bed temperature and dilute aluminum feed concentration. Feed sodium concentration and product alpha alumina content were found to have minor effect on intra-particle porosity. Results also show that an inverse relationship exists between the nitrate content of the calcine and the calcination temperature. (auth)

1162 (IDO-14592) THERMAL CONDUCTIVITY OF ALUMINA PRODUCED BY THE FLUIDIZED BED PROCESS. Paul N. Kelly (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Sept. 4, 1962. Contract AT(10-1)-205. 25p.

The thermal conductivity of granular, free-flowing alumina produced fluidized bed calcination of simulated aqueous waste from uranium–aluminum alloy fuels was determined experimentally in the temperature range of 100 to 2800°F. The thermal conductivity varied from 0.08 at 100°F to 0.30 BTU/(hr)(ft^2)(°F/ft) at 2800°F. (auth)

1163 (ORNL-TM-376) WASTE TREATMENT AND DISPOSAL PROGRESS REPORT FOR APRIL–MAY 1962. R. E. Blanco and E. G. Struxness (Oak Ridge National Lab., Tenn.). Nov. 5, 1962. Contract [W-7405-eng-26]. 72p.

Chemical and material balance flowsheets were prepared for the pot calciner pilot plant, which is to be installed at Hanford. As part of the mechanical testing program, it was demonstrated that already designed pots can be satisfactorily sealed by welding. A test rack was designed for testing calciner feed pumps, and a design study indicated the practicability of installing radioactive hot cell equipment for evaporation-calcination tests in an existing facility originally intended for self-sintering experiments with high-activity wastes. In two engineering-scale runs, simulated high-activity waste was satisfactorily evaporated and pot-calcined. In the first run a large fraction of the Hg volatilized from the calcination pot and was returned to the evaporator. An Hg trap in the primary off-gas line, in the second run collected only 19% of the Hg. Type 304L stainless steel coupled to Ti was corroded at a rate of 77 mils/month during the final 2 hr of a TBP-25 evaporation-glass fixation cycle (900°C) compared with an estimated 61 mils/month when exposed alone the Ti was corroded at a rate of 31 mils/month. Aluminum borophosphate glasses were prepared which incorporated up to 17 wt % Darex waste oxides, gave volume reductions of 2.5 to 3.8 and had bulk densities between 2.44 and 2.74 g/ml and initial softening points of 750 to 850°C. Incorporation of 25 wt % Darex waste oxides in similar glasses resulted in products which became devitrified to give crystalline or segregated glassy materials. A semicontinuous fixation of TBP-25 waste in phosphate-lead glass resulted in volatilization of about 16% of the Ru; physical entrainment of the Pm^{147} present was only about 0.1%. Operation with a rising liquid level and a minimum inventory of unmelted solid appears to be advantageous for Ru control. A container of a similar glass held 4 weeks at 900°C developed a vacuum which eventually reached 27 in. H_2O. The presence of phosphates in the low-level plant feed caused a premature resin column fission product breakthrough during one of the runs after 1022 bed volumes had been treated. Run HR-10 was successfully made with decontamination factors for Sr^{90} and Cs^{137} of 2880 and 181, respectively, after 1500 resin bed volumes, representing <1% of MPC_w for both isotopes. Recirculation

of 5 to 10% of the clarifier solids to a laboratory scale flash mixer lowered the total hardness of the clarifier effluent (caustic-copperas treatment) to 8 to 14 ppm (as $CaCO_3$). Addition of copperas to the flocculator instead of the flash mixer lowered the clarifier effluent hardness to 5.2 ppm. The presence of 1.7 to 2.4 ppm Turco 4324 in tests with ORNL tap water had no effect on total hardness of the effluent but 3.2 ppm increased flash mixer and clarifier effluent hardness to 44 and 37 ppm, respectively. BO-4 grade vermiculite was inferior to CS-100 resin in terms of flow rate, pressure drop, and decontamination factor. With vermiculite and a feed flow rate of 0.25 ml/cm^2 · min, 50% Cs breakthrough occurred at 1000 bed volumes and the Sr d.f. was ~1000 at 1500 bed volumes. Decontamination decreased with increasing flow rate. With CS-100 resin at a flow rate of 5 ml/cm^2 · min, the d.f.'s for Sr and Cs were 1100 and 1800, respectively, at 1500 bed volumes. A cost study of the shipment of calcined solids in 6, 12, and 24-in.-dia cylinders was completed. Costs were lowest for shipment in the largest casks considered manageable, 60 in. ID and containing four 24-in.-dia, nine 12-in. dia, or thirty-six 6-in.-dia cylinders. Some wastes would have to be aged before shipping to allow heat generating fission products to decay. The longest decay time required was 11 years for acidic Purex waste in 24-in.-dia cylinders. Weights and costs of casks at minimum ages were about 100 tons and $50,000 for iron casks, 80 tons and $120,000 for lead casks, and 65 tons and $650,000 for depleted U casks. Shipping costs were lowest in all cases for Pb casks, and ranged from 0.70×10^{-3} mil/kwh_e acidic Purex in 24-in.-dia cylinders for a 1000-mile round trip to 32×10^{-3} mil/kwh_e for reacidified Thorex in smaller cylinders for a 3000-mile round trip. The low-activity wastes being considered for disposal by deep-well injection require containment for about 200 years. Intermediate-activity wastes, requiring containment for 450 years, may be considered for disposal by this method if low-activity wastes can be handled satisfactorily. It is unlikely that high-activity wastes resulting from chemical processing of spent reactor fuel elements will be released to the ground without first immobilizing the fission products. Sr^{90}, the major contributor to the hazard of the waste, will move only 1 to 10% as fast as the transporting water because of ion exchange. Precipitation reactions will provide additional restrictions to radiostrontium movement. Cs^{137} is expected to move much more slowly than Sr^{90} because of highly selective exchange reactions. Ru^{106} movement is not likely to be hazard-controlling. Salt samples from the Carey Salt Mine at Hutchinson, Kansas, fractured at about 250°C and released trapped moisture totaling 0.106 to 0.293% of the weight of the salt. Salt from the Carey Mine at Lyons with a moisture content of 0.048% to 0.100% broke up at about 215°C. The Subcommittee on Bottom Sediments, Clinch River Study, met on May 10, 1962 to compile and evaluate all available data pertaining to deposition of and radioactivity associated with bottom sediments of the Clinch and Tennessee Rivers. A draft of the evaluation is in preparation for review in early July 1962. A highly selective sorbent for Sr was prepared by heating gibbsite ($Al(OH)_3$) above its decomposition temperature of 150°C. Aluminum oxides with high surface area (>200 m^2/g) were formed, in contrast to the low surface area (~0.3 m^2/g) for the original gibbsite. Distribution coefficient (K_d) ranged from 4000 to 40,000 when the solid/solution ratio was increased from 0.001 g/50 ml to 0.05 g/50 ml to 0.05 g/50 ml. A raw Al ore (bauxite) containing 40% gibbsite showed good Sr-sorbing properties when the gibbsite component was decomposed by heating. Ru^{106} determinatives on a series of soil samples taken within the bed of former White Oak Lake indicated that (1) as of February 1962, there was approximately 1200 curies of Ru^{106} in the bed; (2) Ru^{106} concentrations are highest in the top 2 in. of soil; (3) about 75% of the activity in the lake bed is associated with the first 2 ft of soil; (4) and, although Ru^{106} is being transported by ground water through the lake bed soil, a relatively small amount of it reaches the creek in this way. The activity flows onto the bed from two streams that drain the intermediate-activity waste pit area. In continuous tests with ORNL tap water and low-activity waste, the total dissolved hardness was reduced to <2 ppm, as Ca, by precipitation with 0.005 M each of NaOH and Na_2CO_3, coagulation with ~2 ppm Fe^{3+}, and filtration in a sludge column clarifier. Suspended hardness was <0.2 ppm. Beaker tests showed that Turco 4234, Fab, sodium hexametaphosphate, and sodium pyrophosphate all had more deleterious effects on water softening with 0.01 M NaOH than on softening with NaOH-Na_2CO_3. (auth)

1164 THE DISPOSAL OF HIGH SPECIFIC ACTIVITY WASTES. II. WASTE FIXATION INTO CLAY MINERALS. Jaroslav Saidl (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Jaderna Energie, 8: 314-18(1962). (In Czech.)

The use of clay minerals of Czechoslovak provenience for the fixation of radioactive cesium and strontium is discussed. A survey of research work is given. (auth)

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Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

ä	becomes	ae
ö		oe
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As an aid to the users of this index, references to report numbers, where appropriate, are included after the abstract number of the citation.

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6135	17-832	Phys. Rev. 128: 761-7(1962)
6181	17-705	Dep.(mc); $1.10(fs), $0.80(mf) OTS
6191	17-855	Phys. Rev. 128: 1287-96(1962)
6214	17-706	Dep.(mc); $2.60(fs), $0.89(mf) OTS
6230	17-871	Phys. Rev. 128: 1916-20(1962)
6232	17-707	Dep.(mc); $1.60(fs), $0.80(mf) OTS
6261	17-764	Phys. Rev. 128: 1823-35(1962)
6262	17-765	Phys. Rev. 128: 1836-41(1962)
CEA-	**(French)**	
2153	17-409	Dep.(mc)
2165	17-306	Dep.(mc)
2166	17-190	Dep.(mc)
2173	17-266	Dep.(mc)
2175	17-1001	Dep.(mc)
2184	17-329	Dep.(mc)
CERN-	**(European Organization for Nuclear Research)**	
62-20	17-708	Dep.(mc)
62-22	17-794	Dep.(mc)
62-27	17-795	Dep.(mc)
CF-	**(Oak Ridge National Laboratory)**	
55-6-196	17-252	See ORNL-TM-386
59-12-8	17-798	See ORNL-TM-388
CLM-R-	**(British)**	
22	17-330	Dep.; $0.35(BIS); 2s.6d.(HMSO)
CRC-	**(Canadian)**	
1095	17-1002	Dep.; $1.00(AECL)
CRCE-	**(Canadian)**	
1042	17-225	Dep.; $1.00(AECL)
CREL-	**(Canadian)**	
1073	17-356	Dep.; $1.50(AECL)
CRRD-	**(Canadian)**	
1102	17-357	Dep.; $0.20(AECL)
CRT-	**(Canadian)**	
1052	17-400	Dep.(mc); $0.50(AECL)
CU-	**(Misc.)**	
15-AT(30-1) 755 Chem.	17-389	See TID-16834
34-62-AEC-1019-Chem.	17-796	See NEVIS-109
216	17-711	See NEVIS-110
CU(PNPL)		
218	17-602	Dep.(mc); $7.60(fs), $2.54(mf) OTS
CW-R&DL-	**(Canadian)**	
29	17-509	Dep.; $1.50(AECL)
CWAED-	**(Canadian)**	
54	17-510	Dep.; $1.50(AECL)
DLCS-		
5000862	17-1113	Dep.(mc); $4.60(fs), $1.43(mf) OTS
5000962	17-1114	Dep.(mc); $4.60(fs), $1.55(mf) OTS
DMIC-	**(Non-AEC)**	
174	17-511	$1.75(fs) OTS
175	17-410	$1.75(fs) OTS
DMIC-Memo-	**(Non-AEC)**	
158	17-512	$1.00(OTS)
DRI-	**(Misc.)**	
2042	17-530	Dep.(mc); $3.60(fs), $1.22(mf) OTS
EFINS-	**(Misc.)**	
62-15	17-726	Ann. Phys. (N. Y.), 19: 458-95(1962)
62-29	17-652	Phys. Rev. 128: 1530-8(1962)
EURAEC-		
5	17-546	Dep.(mc); $1.60(fs), $0.80(mf) OTS
48	17-1115	Dep.(mc); $3.60(fs), $1.37(mf) OTS
51	17-358	Dep.(mc); $3.60(fs), $1.40(mf) OTS
293	17-502	Dep.(mc); $8.10(fs), $2.84(mf) OTS
294	17-275	Dep.(mc); $1.10(fs), $0.80(mf) OTS
298	17-234	Dep.(mc); $1.60(fs), $0.80(mf) OTS
303	17-276	Dep.(mc); $1.60(fs), $0.80(mf) OTS
305	17-257	Dep.(mc); $1.10(fs), $0.80(mf) OTS
308	17-291	Dep.(mc); $4.60(fs), $1.58(mf) OTS
313	17-267	Dep.(mc); $3.60(fs), $1.40(mf) OTS
314	17-1054	Dep.(mc); $1.60(fs), $0.80(mf) OTS
320	17-531	Dep.(mc); $10.10(fs), $4.04(mf) OTS
335	17-527	See ATL-A-131
340	17-547	Dep.(mc); $1.10(fs), $0.80(mf) OTS
341	17-548	Dep.(mc); $4.60(fs), $1.43(mf) OTS
342	17-340	Dep.(mc); $2.60(fs), $0.83(mf) OTS
351	17-520	Dep.(mc); $1.10(fs), $0.80(mf) OTS
369	17-521	Dep.(mc); $2.60(fs), $0.83(mf) OTS
376	17-494	Dep.(mc); $1.60(fs), $0.80(mf) OTS
395	17-277	Dep.(mc); $1.10(fs), $0.80(mf) OTS
404	17-278	Dep.(mc); $1.10(fs), $0.80(mf) OTS
421	17-405	See ARF-2198-31
425	17-493	See BMI-X-10003
426	17-529	See BMI-X-10007
427	17-1051	See TID-17026
FD-	**(Canadian)**	
86	17-331	Dep.; $0.50(AECL)
FTD-TT-	**(Non-AEC)**	
61-395	17-279	OTS
62-226	17-258	OTS
62-1068	17-1132	OTS

Report No.	Abstract No.	Availability
FXM–	**(Misc.)**	
406	17-1003	Dep.(mc); $2.60(fs), $1.01(mf) OTS
GA–	**(Misc.)**	
2963	17-1116	Dep.; $2.50(OTS)
GAMD–	**(Misc.)**	
1542	17-1117	Dep.(mc); $8.10(fs), $2.84(mf) OTS
1652	17-1118	Dep.(mc); $5.60(fs), $1.79(mf) OTS
3276	17-1004	Dep.(mc); $2.60(fs), $0.95(mf) OTS
GEAP–	**(Misc.)**	
3372*	17-1119	
3643*	17-1112	See APED-3958
4054	17-1005	Dep.(mc); $11.00(fs), $4.55(mf) OTS
4067	17-587	Dep.(mc); $1.60(fs), $0.80(mf) OTS
GEMP–		
16A	17-588	Dep.; $0.75(OTS)
105	17-532	Dep.(mc); $2.60(fs), $1.07(mf) OTS
HW–		
26499(Del.)	17-120	Dep.(mc); $3.60(fs), $1.16(mf) OTS
57662	17-332	Dep.(mc); $1.60(fs), $0.80(mf) OTS
60145	17-1006	Dep.(mc); $1.10(fs), $0.80(mf) OTS
61743	17-359	Dep.(mc); $1.10(fs), $0.80(mf) OTS
64684	17-513	Dep.; $9.60(fs), $3.71(mf) OTS
69169	17-589	$3.60(fs), $1.40(mf) OTS
69488	17-1148	Dep.(mc); $3.60(fs), $1.40(mf) OTS
72263(Rev.)	17-1120	Dep.(mc); $1.60(fs), $0.80(mf) OTS
73511	17-495	Dep.; $1.00(OTS)
73653(Rev.)	17-1007	Dep.(mc); $1.60(fs), $0.80(mf) OTS
74609	17-226	Dep.(mc); $3.60(fs), $1.31(mf) OTS
74643	17-292	Dep.; $2.60(fs), $0.83(mf) OTS
HW-SA–		
2633	17-216	Dep.(mc); $1.60(fs), $0.80(mf) OTS
2677	17-1009	Dep.(mc); $3.60(fs), $1.16(mf) OTS
2744	17-1159	Dep.(mc); $2.60(fs), $0.89(mf) OTS
IA–	**(Non-AEC)**	
633	17-411	Dep.(mc)
720	17-146	Dep.(mc)
735	17-191	Dep.(mc)
736	17-227	Dep.(mc)
IDO–		
12023	17-121	Dep.(mc); $2.60(fs), $0.98(mf) OTS
14569	17-228	Dep.; $1.50(OTS)
14586	17-1160	Dep.; $2.25(OTS)
14587	17-1161	Dep.; $0.50(OTS)
14592	17-1162	Dep.; $0.50(OTS)
16689	17-1009	Dep.; $1.50(OTS)
16790	17-1010	Dep.; $2.75(OTS)
16791	17-1011	Dep.; $4.50(OTS)
16801	17-268	Dep.; $0.50(OTS)
24040	17-1149	Dep.(mc); $28.50(fs), $10.75(mf) OTS
IFA-EM–	**(Rumanian)**	
47	17-709	Dep.(mc)
IM–	**(Canadian)**	
48	17-333	Dep.(mc)
INSJ–	**(Japanese)**	
50	17-883	Dep.(mc)
IS–		
370	17-573	Phys. Rev. 128: 1044-53(1962)
377	17-229	Dep.(mc); $2.60(fs), $1.10(mf) OTS
420	17-230	Dep.; $1.75(OTS)
488	17-650	Phys. Rev. 128: 1512-19(1962)
557	17-147	Dep.(mc); $6.60(fs), $2.27(mf) OTS
JAERI–	**(Japanese)**	
1024	17-1150	
1027	17-1151	
4022	17-334	
JEN–	**(Spanish)**	
95-DMe/I-8	17-148	Dep.(mc)
104-DMe/I-10	17-231	Dep.(mc)
105-DQ/I-32	17-192	Dep.(mc)
106-DMa/I-14	17-217	Dep.(mc)
JPRS–	**(Non-AEC)**	
15432	17-182	$38.50(OTS)
15524	17-697	OTS
15740	17-607	OTS
JUL–	**(German)**	
54-RE	17-1042	Dep.(mc)
55-ST	17-307	Dep.(mc)
K–		
1536	17-386	Dep.; $1.25(OTS)
KAPL–		
2000-19	17-496	Dep.; $2.25(OTS)
2221	17-412	Dep.; $1.00(OTS)
LA–		
2707	17-1121	Dep.; $1.75(OTS)
2715	17-954	Dep.; $1.50(OTS)
2733	17-1043	Dep.; $2.00(OTS)
LADC–		
4854	17-18	Advances in Cryogenic Eng. 7: 311-17 (1962)
4856	17-16	Advances in Cryogenic Eng. 7: 198-205 (1962)
5092	17-851	Phys. Rev. 128: 1268-70(1962)
5181	17-735	Phys. Rev. 128: 707-11(1962)
5282	17-565	Phys. and Chem. Solids 23: 1191-9(1962)
5283	17-566	Phys. and Chem. Solids 23: 1201-8(1962)
5306	17-651	Phys. Rev. 128: 1520-30(1962)
5368	17-672	Phys. Rev. 128: 1381-3(1962)
5382	17-854	Phys. Rev. 128: 1281-6(1962)
5480	17-603	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5487	17-149	Dep.(mc); $1.60(fs), $0.80(mf) OTS
LAMS–		
2259	17-1122	Dep.(mc); $3.60(fs), $1.37(mf) OTS
2713	17-785	Dep.; $1.00(OTS)
2740	17-710	Dep.; $1.50(OTS)
2745	17-604	Dep.; $1.75(OTS)
2747	17-786	Dep.; $0.50(OTS)
2756	17-193	Dep.; $0.50(OTS)
MAN-Tko–	**(German)**	
09-10-62	17-278	See EURAEC-404
MATT–		
145	17-955	Dep.(mc); $5.60(fs), $2.00(mf) OTS
MLM–		
1128	17-413	Dep.; OTS
MPR-XIII–		
8-62	17-272	See TID-16813
MRC-TSR–	**(Non-AEC)**	

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280	17-950	See AD-273247
MSAR–	**(Misc.)**	
61-29	17-533	Dep.(mc); $1.60(fs), $0.80(mf) OTS
62-23	17-534	Dep.(mc); $1.10(fs), $0.80(mf) OTS
MSUCP–		
7	17-401	Dep.(mc); $7.60(fs), $2.33(mf) OTS
9	17-884	Dep.(mc); $4.60(fs), $1.52(mf) OTS
10	17-402	Dep.(mc); $6.60(fs), $2.09(mf) OTS
11	17-885	Dep.(mc); $12.00(fs), $5.15(mf) OTS
12	17-886	Dep.(mc); $1.60(fs), $0.80(mf) OTS
MTI–	**(Misc.)**	
62TR-21	17-253	See TID-16947
NA–	**(Non-AEC)**	
62H-46	17-505	See AD-272693
NAA-SR–		
5675	17-1123	Dep.; $0.75(OTS)
6490	17-247	Dep.(mc); $4.60(fs), $1.43(mf) OTS
7036	17-1124	Dep.; $0.50(OTS)
7138	17-514	Dep.; $1.25(OTS)
NAA-SR-Memo–		
6798	17-269	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7354	17-535	Dep.(mc); $3.60(fs), $1.25(mf) OTS
7526	17-1125	Dep.(mc); $2.60(fs), $0.86(mf) OTS
NASA-TN–	**(Misc.)**	
D-1323*	17-1156	$2.00(OTS)
D-1441*	17-270	$1.00(OTS)
D-1529*	17-1126	$0.50(OTS)
NAVWEPS-REPORT	**(Non-AEC)**	
7617	17-517	See NOTS-TP-2616
NDA–	**(Misc.)**	
2014-162*	17-1044	Dep.(mc); $1.10(fs), $0.80(mf) OTS
NEVIS–	**(Misc.)**	
109	17-796	Dep.(mc); $4.60(fs), $1.46(mf) OTS
110	17-711	Dep.(mc); $1.10(fs), $0.80(mf) OTS
NIRL-R–	**(British)**	
20	17-887	Dep.(mc); $0.49(BIS); 3s.6d.(HMSO)
NLCO–		
857	17-515	Dep.; $0.75(OTS)
NMI–	**(Misc.)**	
2108	17-414	Dep.(mc); $1.60(fs), $0.80(mf) OTS
2109	17-415	Dep.(mc); $1.60(fs), $0.80(mf) OTS
4313(Pt.I)	17-516	Dep.(mc); $11.00(fs), $4.46(mf) OTS
NOTS-TP–	**(Non-AEC)**	
2616	17-517	$1.00(fs) OTS
NP–	**(AEC File No. for Non-AEC Reports)**	
12085	17-150	Dep.(mc)
12088	17-248	Dep.(mc)
12101	17-1045	Dep.(mc)
12109	17-116	Dep.(mc)
12128	17-536	Dep.(mc)
12129	17-797	Dep.
12130	17-416	
12146	17-249	
12147	17-250	
12148	17-251	
12150	17-956	
12152	17-518	
12153	17-957	$3.60(fs) OTS
12154	17-958	
12157	17-1127	Dep.(mc)
12158	17-1046	
12159	17-360	
12160	17-959	
12161	17-271	$10.10(fs) OTS
12162	17-417	$4.60(fs) OTS
12164	17-418	Dep.(mc); $0.50(Dept. of Mines and Tech. Surveys, Ottawa)
12170	17-419	$7.60(fs) OTS
12171	17-960	
12174	17-420	
NRL–	**(Misc.)**	
5838*	17-712	
NYO–		
9360	17-361	Dep.(mc); $3.60(fs), $1.16(mf) OTS
9772	17-308	Dep.; $2.25(OTS)
10228	17-614	Ann. Phys. (N. Y.), 19: 351-82(1962)
10237	17-770	Phys. Rev. 128: 1921-7(1962)
10247	17-713	Dep.(mc); $3.60(fs), $1.37(mf) OTS
10471	17-335	Dep.(mc); $4.60(fs), $1.49(mf) OTS
ORNL–		
2971(Vol.6)	17-3	Dep.; $3.50(OTS)
ORNL-TM–		
237	17-403	Dep.(mc); $1.10(fs), $0.80(mf) OTS
362	17-888	Dep.(mc); $1.60(fs), $0.80(mf) OTS
376	17-1163	Dep.(mc); $7.60(fs), $2.36(mf) OTS
379	17-1152	Dep.(mc); $2.60(fs), $0.89(mf) OTS
386	17-252	Dep.(mc); $2.60(fs), $0.89(mf) OTS
387	17-1047	Dep.(mc); $9.10(fs), $3.35(mf) OTS
388	17-798	Dep.(mc); $1.10(fs), $0.80(mf) OTS
404	17-404	Dep.(mc); $1.60(fs), $0.80(mf) OTS
OTS–	**(Misc.)**	
60-51035*	17-324	$0.50(OTS)
60-51083*	17-549	$2.50(OTS)
PATENTS	**(British)**	**3s. 6d. each, U. K. Patent Office**
906,556	17-1146	
906,576	17-524	
906,618	17-245	
906,638	17-586	
906,667	17-290	
906,706	17-350	
906,719	17-246	
906,827	17-1100	
906,896	17-1101	
906,932	17-296	
906,979	17-992	
907,012	17-297	
PATENTS	**(U. S.)**	**$0.25 each, U. S. Patent Office**
3,055,814	17-119	
3,055,818	17-215	
3,055,820	17-1147	
3,056,024	17-262	
3,056,027	17-351	
3,056,047	17-383	
3,056,059	17-384	
3,056,069	17-263	
3,056,123	17-385	
PPL-TR–	**(Non-AEC)**	
61-17(398)	17-961	$3.60(fs) OTS

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PRDC-TR–		
57	17-1049	Dep.(mc); $1.60(fs), $0.80(mf) OTS
PST-Cat.–	**(Misc.)**	
320*	17-324	See OTS-60-51035
387*	17-549	See OTS-60-51083
PUC–		
1962-70	17-859	Phys. Rev. 128: 1321-8(1962)
1962-76	17-835	Phys. Rev. 128: 790-1(1962)
1962-82	17-870	Phys. Rev. 128: 1810-19(1962)
Q–	**(Non-AEC)**	
B1933-3	17-417	See NP-12162
RC–	**(Misc.)**	
195*	17-420	See NP-12174
RCN–	**(Dutch)**	
7	17-154	Acta Cryst. 15: 92-3(1962)
RFP–		
265	17-232	Dep.(mc); $1.60(fs), $0.80(mf) OTS
285	17-293	Dep.; $0.50(OTS)
RISO–	**(Danish)**	
42	17-362	Dep.(mc)
RT-MET–	**(Italian)**	
(62)3	17-536	See NP-12128
SCL-T–		
443	17-722	Dep.(mc); $1.60(fs), $0.80(mf) JCL
SLAC–		
1	17-889	Dep.; $2.00(OTS)
SR–	**(Misc.)**	
58*	17-249	See NP-12146
SRB–	**(Non-AEC)**	
62-4	17-714	OTS
SRO–		
73	17-1049	Dep.(mc); $1.10(fs), $0.80(mf) OTS
STI-DOC–	**(International Atomic Energy Agency)**	
10/9	17-4	Dep.(mc)
STI-Pub.–	**(International Atomic Energy Agency)**	
15/23/24	17-219	$1.00; 21s; NF 4; DM 3.20(IAEA)
42(Vol.I) (p.591-7)	17-366	See AEC-tr-5369
49(Vol.I) (p.65-74)	17-787	See AEC-tr-5413
53	17-1136	$5.00(IAEA)
57(Vol.I)	17-1070	$10.00; 210s; NF 40; DM 35(IAEA)
57(Vol.II)	17-1083	$10.00; 210s; NF 40; DM 35(IAEA)
STL-AB–	**(Non-AEC)**	
60-5111-37	17-122	See STL-B-37
STL-B–	**(Non-AEC)**	
37	17-122	
TID–		
3713	17-5	Dep.; Free (DTI Extension)
6613(Suppl.3)	17-323	Dep.; $2.50(OTS)
14627	17-71	Intern. J. Radiation Biol. 5: 205-15 (1962)
14686	17-861	Phys. Rev. 128: 1336-41(1962)
15749	17-605	Dep.; $4.50(OTS)
15926	17-860	Phys. Rev. 128: 1328-35(1962)
15938	17-825	Phys. Rev. 128: 694-9(1962)
15946	17-831	Phys. Rev. 128: 751-60(1962)
16067	17-755	Phys. Rev. 128: 1394-1401(1962)
16088	17-828	Phys. Rev. 128: 720-8(1962)
16170	17-866	Phys. Rev. 128: 1783-8(1962)
16178	17-739	Phys. Rev. 128: 826-30(1962)
16255	17-671	Phys. Rev. 128: 1166-74(1962)
16265	17-737	Phys. Rev. 128: 779-89(1962)
16266	17-830	Phys. Rev. 128: 740-50(1962)
16279	17-865	Phys. Rev. 128: 1778-82(1962)
16415	17-169	Phys. Rev. 128: 627-30(1962)
16535	17-962	Dep.(mc); $7.60(fs), $2.57(mf) OTS
16623	17-715	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16626	17-839	Phys. Rev. 128: 821-5(1962)
16629	17-577	Phys. Rev. 128: 1136-9(1962)
16630	17-570	Phys. Rev. 128: 622-6(1962)
16695	17-233	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16712	17-387	Dep.(mc); $4.60(fs), $1.46(mf) OTS
16715	17-388	$2.60(fs), $0.86(mf) OTS
16730	17-1128	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16781	17-299	Dep.(mc); $2.60(fs), $0.95(mf) OTS
16785	17-1050	Dep.(mc); $8.10(fs), $2.63(mf) OTS
16786	17-716	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16813	17-272	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16834	17-389	Dep.(mc); $11.00(fs), $4.61(mf) OTS
16859	17-336	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16861	17-337	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16862	17-180	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16877	17-33	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16884	17-338	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16885	17-339	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16947	17-253	Dep.(mc); $2.60(fs), $0.98(mf) OTS
16950	17-799	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16960	17-800	Dep.(mc); $3.60(fs), $1.25(mf) OTS
16963	17-801	Dep.(mc); $3.60(fs), $1.13(mf) OTS
16965	17-802	Dep.(mc); $3.60(fs), $1.13(mf) OTS
16971	17-803	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16974	17-804	Dep.(mc); $9.60(fs), $3.74(mf) OTS
16984	17-805	Dep.(mc); $2.60(fs), $0.89(mf) OTS
16985	17-806	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16986	17-717	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16987	17-151	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16989	17-807	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16997	17-963	Dep.(mc); $1.10(fs), $0.80(mf) OTS
17006	17-537	Dep.(mc); $4.60(fs), $1.46(mf) OTS
17007	17-421	Dep.(mc); $9.60(fs), $3.71(mf) OTS
17011	17-422	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17014	17-718	Dep.(mc); $5.60(fs), $1.97(mf) OTS
17018	17-606	Dep.(mc); $10.50(fs), $4.31(mf) OTS
17019	17-181	Dep.(mc); $6.60(fs), $2.18(mf) OTS
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17026	17-1051	Dep.(mc); $5.60(fs), $2.00(mf) OTS
UAC–		
6658	17-337	See TID-16861
6660	17-336	See TID-16859
6661	17-33	See TID-16877
UCRL–		
6479	17-826	Phys. Rev. 128: 700-7(1962)
6796	17-629	J. Chem. Phys. 37: 1012-17(1962)
6875	17-852	Phys. Rev. 128: 1271-6(1962)
6929	17-662	Phys. Rev. 128: 1758-60(1962)
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9599	17-719	Dep.(mc); $1.60(fs), $0.80(mf) OTS
9911	17-827	Phys. Rev. 128: 711-19(1962)

Report No.	Abstract No.	Availability
10026	17-771	Phys. Rev. 128: 1935-9(1962)
10060	17-867	Phys. Rev. 128: 1788-90(1962)
10088	17-833	Phys. Rev. 128: 767-74(1962)
10157	17-772	Phys. Rev. 128: 1939-44(1962)
10169	17-863	Phys. Rev. 128: 1740-6(1962)
10177	17-767	Phys. Rev. 128: 1868-80(1962)
10202(Rev.)	17-660	Phys. Rev. 128: 1733-40(1962)
10204	17-999	Phys. Rev. 128: 1963-9(1962)
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11	17-1039	See IDO-16791(p.297-301)
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11(Pt.II)	17-1031	See IDO-16791(p.236-41)
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